THURSDAY, AUGUST 18, 1898.

## THE CORRESPONDENCE OF HUYGENS.

*Œuvres complètes de Christiaan Huygens publiées par la Société Hollandaise des Sciences. Tome Septième. Correspondence* 1670–1675. Pp. 624. 4to. (La Haye, 1897.)

SEVEN large quarto volumes of letters to and from Huygens have now been published; but the completion of the work is not yet in sight, as the volume before us only reaches the end of the year 1675, and Huygens lived till 1695. We may therefore probably look forward to three or four more volumes, making in all ten or eleven, before this undertaking is brought to a close. A future historian of science in the seventeenth century will no doubt find excellent material in this vast collection of letters exchanged between Huygens and the principal physicists, astronomers, and mathematicians of his time, to which are added many short papers, reprinted from the *Journal des Savants* and the *Phil. Trans.* But, on the other hand, the task of the historian would have been materially lightened if he had been spared the trouble of wading through a great many uninteresting, more or less private, letters, which help to swell these bulky volumes, but which might very well have been omitted. This is particularly the case with the letters written to Lodewijk Huygens, for though they bear witness to the brotherly affection of the writer, and are often of interest as throwing light on the state of the Netherlands in the days of William III., particularly in the year 1672, when the armies of Louis XIV. overran the country, and the last days of the Republic seemed to have come, still most of these letters are rather out of place among the scientific ones, and would have been better published separately. But hero-worship is unfortunately a disease which it is extremely difficult to resist, and we can well understand that the Dutch Society of Science has wished to do honour to their great countryman by giving as complete a picture of him as possible, both as a private man and as a philosopher.

The years covered by the present volume, 1670–1675, were by Huygens spent in Paris, where he had resided since 1666, except the period from the summer of 1670 till the following spring, which he spent in his native country in order to recover his health after a severe illness in the beginning of 1670. It was a stirring time in the scientific world. The discovery of the solar spectrum by Newton and the method of drawing tangents to curves discovered by Sluse were published in 1672, the "Horologium Oscillatorium" of Huygens was issued in 1673, giving to the world the theory of the pendulum, the discovery of evolutes, the isochronism of the cycloid and other problems of importance; while the application of a spiral spring to the balance of a watch was first announced in 1675. These and other matters are discussed in the correspondence; while the great respect in which Huygens was held is also shown by letters on other subjects, on which his opinion was asked. Thus the architect Perrault, the builder of the palatial Paris Observatory, "le plus somptueux monument qu'on a jamais consacré à l'astronomie," as Lalande calls it, sends Huygens a long essay giving his ideas about the origin of springs in the earth; it forms the preface to his "Traité de l'Origine des Fontaines," and need therefore not have been inserted among the correspondence of Huygens, as the reply of the latter, in which he shortly gives the theory of the barometer and the syphon, can be read without reference to Perrault's essay. We also find Huygens consulted on matters more outside his own sphere; thus he and Hudde in 1671, at the request of the States of Holland and West Frisland, sent a lengthy report to the States-General on the deepening and regulation of the Lower Rhine and the Yssel, on which subject Huygens and Hudde also exchanged several letters.

There are not many letters in this volume on practical astronomy, for the simple reason that most practical astronomers at that time lived in Paris; Cassini, Picard and Roemer were there; in England, Flamsteed and Halley were still young men, and in the rest of Europe there were simply no observers except Hevelius. There are, however, some letters and short papers (some of which were printed at the time in the *Journal des Savants*) on the disappearance of Saturn's ring in 1671, in which year the earth twice passed through the plane of the ring and supplied a splendid confirmation of Huygens' discovery of the true nature of the appendages of the planet. The phenomena were carefully observed both by Huygens himself and at the new Paris Observatory by Cassini, who shortly afterwards discovered two satellites of Saturn with the new telescopes constructed by Campani. The excellence of these is acknowledged by Huygens in a letter to his brother Constantin, in which he humorously remarks that though the new lenses of 36 and 46 feet focal length show mountains and other surface-details on the moon much better than the old ones did, we have not yet got so far as to see church spires and trees. The construction of telescopes was a subject in which the two brothers were both specially interested, and on several occasions Christian sent Constantin information about the new methods of polishing lenses practised in Paris by Le Bas and Borel. It is well known that the single-lens objectives of those days were of very great focal length; there was one of 60 feet at the Paris Observatory, which was very troublesome to use, and Borel even boasted of having made one of 150 feet; "mais il est Gascon," says Huygens.

In England the desire of getting achromatic telescopes had led Gregory and Newton to the invention of the reflecting telescope. In this country Huygens, who was himself a Fellow of the Royal Society, had an indefatigable correspondent in Oldenburg, who not only as secretary to the Society and editor of the *Philosophical Transactions*, but also by his very extensive correspondence, was one of the chief centres of scientific life. At the desire of the Society, Oldenburg communicated an account of Newton's invention to Huygens, who published it in the *Journal des Savants* of February 29, 1672, and also sent his brother Constantin a description of it. He tried at once to make a mirror for himself, but found great practical difficulties in getting a good polish with-

 R

out altering the figure. His defence of Newton's construction against the objections of Cassegrain is reprinted in this volume from the *Journal des Savants*. With Newton himself Huygens does not seem to have been in direct communication, but through Oldenburg the doubts of the Dutch philosopher as to the actual number of colours in the sun-spectrum were brought to the knowledge of Newton, who replied to them in two papers printed in the *Philosophical Transactions* and reprinted in the present volume. The first and last pages of one of the papers, which was written in the form of a letter to Oldenburg, are given in facsimile.

Among letters concerning Huygens' principal work, the "Horologium Oscillatorium," we find his well-known letter to Leopold de' Medici of May 1673, protesting against the accusation of plagiarism, which for years caused him a great deal of annoyance. Both this letter as well as Leopold's reply have been printed before, but the editor takes the opportunity of reviewing in a very long footnote the whole question as to the priority of Galileo. The *mensurator temporis* actually constructed by Galileo was a failure, but in 1641 he gave verbal instructions to his son Vincenzio which resulted in a design of the latter described by Viviani in 1659 in a report to Leopold of Toscana. The editor maintains that a clock can never have been made from this design, or that if made it must have been impossible to make it go, as the wheel would have oscillated instead of rotating; but this conclusion seems very doubtful, since it depends altogether on the accuracy of the drawing published by Favaro in 1891, from among several existing in the National Library of Florence. In any case it remains an undoubted fact that Galileo was the first to propose the application of pendulums to clocks, that he found the principle of the escapement, and that he only by his age and blindness was prevented from perfecting the invention. The mythical claims of Joost Bürgi, so strenuously advocated by Rudolph Wolf, may be safely dismissed, and that Huygens made the invention quite independently is not doubted by anybody.

Tiresome questions of priority were always cropping up in the seventeenth century, and Huygens had also to deal with such in the matter of the isochronism of the cycloid. He defended himself against the claims of Hooke and others in a letter to Oldenburg in June 1673, which called forth a dignified reply from the latter, in which he says that English philosophers are not in the habit of attributing to themselves the discoveries of others, but neither will they allow others to deprive them of what is theirs; many inventive Englishmen have found new truths of which they have spoken freely before printing anything about them, but of late years they have been more careful to preserve their discoveries through the medium of the *Phil. Trans.* Huygens seems to have taken offence at this, as he did not answer for a long time; and when he wrote again he explained his silence by saying that his letters apparently "ne servoient qu'a me mettre mal avec vos Messieurs dela, les vns ne prenant pas en bonne part la liberté dont j'usois a dire mes sentiments sur leurs ouvrages, et a leur faire des objections, les autres se formant d'autres sujets de mecontentements, ou je n'en attendois point du tout."

The last great invention of Huygens dealt with in this volume is the application of a spiral spring to the balance of a watch. On January 30, 1675, Huygens in a letter to Oldenburg informed him that he had made a new invention in timekeepers which he announced in an anagram, and a few days later he applied to Colbert for a patent in France for twenty years. The watchmaker Thuret, whom he had employed to carry out the invention, gave Huygens a good deal of anxiety by pretending that the invention was his own, or at least was made by him and Huygens jointly; but after a few weeks he was obliged to give up his pretensions. Eventually, however, Huygens left all watchmakers at liberty to work at the new invention, foreseeing that any attempt to enforce the patent would involve him in endless lawsuits and expense. A scatter-brained person, Abbé Hautefeuille, had resisted the granting of the patent on the plea that he had himself applied a straight spring to a clock instead of a pendulum, and that the invention of Huygens was essentially the same thing! Of more importance was the claim immediately made by Hooke, that he had many years previously made the same invention and that watches had actually been made in accordance with it. How Hooke stuck to his colours, and how he picked a violent quarrel with Oldenburg, whom he described as "one that made a trade of intelligence" and accused of having betrayed the invention to Huygens, all this is well known, and the present volume, in which all the documents are reprinted, does not throw any additional light on the matter.

In addition to several plates giving photographic reproductions of letters and sketches, the volume contains a fine portrait of Huygens and a view of the manor-house of Zuylichem. The very numerous footnotes give ample information about persons and matters referred to in the letters and documents. J. L. E. DREYER.

## *DANTE'S TEN HEAVENS.*

*Dante's Ten Heavens.* By Edmond G. Gardner, M.A. Pp. xii + 310. (Westminster: A. Constable and Co., 1898.)

THE many works in the English language which are being constantly added to the already colossal Dantesque literature are a subject for sincere congratulation alike to the country which gave birth to the immortal author of the *Divina Commedia*, and to the English nation. It is, I think, the most conclusive proof of the conspicuous greatness of Dante that his fame should increase in proportion as the era of which he was the first bard and prophet advances in civilisation. "Dante's Ten Heavens," by Mr. E. G. Gardner, is one of the latest contributions to the great subject under discussion, and for the earnest and loving care which the author has evidently devoted to his work he deserves unstinted praise. He has studied a great deal of what has been said about Dante's theological and ethical ideas, and, although Mr. Gardner in his book treats especially of the *Paradiso*, he often compares similar passages in the three parts of the poem; so that his work will be of great service to those who are interested in these studies. It is, however, to be regretted that

he has published his work in the form of an essay; in my opinion, he should have appended his notes to an edition of the whole text of the *Paradiso;* for his valuable remarks would then have presented themselves to the reader singly, and each in its proper place; but in the form they have been published, my conviction compels me to say that the uninitiated, for whom the book is avowedly intended, will be rather discouraged or repulsed by the mass of theological and ethical disquisitions the book mainly consists of, with but a very few glimpses of the poetry which richly adorns *Paradiso*, and makes the serious matters dealt with in it attractive, enjoyable, and exalting. In reading Mr. Gardner's book, one would almost think that Dante in his *Paradiso* simply rhymed St. Thomas Aquinas, Dionysius the Areopagite, St. Bernard, and Richard of St. Victor; whereas, in reality, he was the great Christian poet who expressed in the language of his people, and handed down to posterity, vivified and enhanced with his beautiful poetry, the thoughts and ideas which the school and the cloister entertained and preached concerning the deep questions of human existence. Mr. Gardner should have kept in mind the words which he himself quotes on p. 48 of his book:—

> "Metter potete ben per l'alto sale
> Vostro navigio, servando mio solco
> Dinnanzi l'acqua che ritorna uguale."
> Par., C. ii., lines 13–15.

Had he done so, had he been more graphic in his account of the sublime ethereal pilgrimage, his readers would follow much more easily his guidance, and feel a greater interest in the poem. The fact is that Dante's *Paradiso* should be read and studied (with good notes, of course) in the very words of the sublime poet himself; in truth, many passages in the translations already published of it are dim and clumsy rendering of the original, and oftentimes, for anybody who knows any Italian at all, more difficult to understand than the original text itself. Little, far too little is said by Mr. Gardner about the beautiful diction, the marvellous style, and the stupendous poetic conceptions abundantly displayed by Dante in the last, but the greatest and most sublime, of the three parts of the *Divina Commedia;* and he has said scarcely anything at all of his surprising and admirable knowledge of the physical sciences and astronomy. But, surely, it is for these eminent qualities I have just enumerated that Dante is entitled to that great and ever-increasing consideration and admiration which he attracts at the present time; it is the all-surveying, all-embracing, all-stirring character of his intellect that arrests and commands the attention of all the thinking minds of the present inquiring age. As Mr. Gardner cannot, I think, be one of those critics who injudiciously hold that science is opposed to poetry—that the one must inevitably mar the scope of the other—I cannot understand why he does not praise Dante for his great and, considering the age he lived in, truly amazing knowledge of the highest problems of science. Had not Dante's mind been so copiously stored with all the learning of the best instructed of his contemporaries, most certainly his poetic imagination could never have taken its start from the lofty plane it rose from in the *Divina Commedia*, and his *Paradiso* could never have been more than a grand rhapsody. It suffices to compare Dante's magnificent poem with the Vision of Alberigo, the monk of Monte Cassino, or "De Jerusalem Celesti," of Fra Giacomino of Verona, to see how puerile even poetic conceptions will appear when they are expressed by minds untaught, and obliged to rely upon their unaided natural resources.

The *Purgatorio*, and the *Paradiso*, the work of heaven and earth,

> "Al quale ha posto mano e cielo e terra,"
> Par., C. xxv., line 2.

contain innumerable passages, which prove Dante's immense knowledge of the physical sciences, and astronomy. With reference to the physical sciences, I will only mention the following points:—

His allusion to the principle of universal gravitation: Inf., C. xxxiv., lines 73 and 74.

His remarkably accurate description of the origin of rain: Purg., C. v., line 109–112.

His explanation of the way in which the vegetable humour of the vine, fostered by the light and heat of the sun, becomes grapes: Purg., C. xxv., lines 77 and 78.

His knowledge of the theory of the decomposition of light; in fact, the prismatic nature of the solar spectrum: Purg., C. xxix., lines 73–78.

His knowledge that flowers are only leaves metamorphosed: Par., C. xxxvii., lines 38 and 39.

And, to go no further in this department, his recommendation of experiment and scientific observation, in preference to empiricism: Par., C. ii., lines 95–97.

In astronomy, Dante's knowledge was still more remarkable; not so much for any great discovery made by himself, but because of the thorough mastery he possessed of what was then known of that science, and also because of the many theories then advocated, his pre-eminently eclectic mind seems, generally, to have embraced those only which more recent researches have proved to be the correct ones. And if it be said that Dante did not acquiesce in the Pythagorean system of astronomy (*Convito;* Bk. iii., Ch. 5), we must remember that the illustrious astronomer Ptolemy himself also withheld his approval of that grand but badly advocated system, and, what is more, three centuries after Dante the immortal Galileo was, at first, strongly opposed to the Pythagorean system, as revived and supported by Copernicus.

The following lines, for instance, unmistakably show that Dante knew the theory of the Precession of the Equinoxes, in about 26,000 years. To indicate the vanity of worldly fame, Dante makes a spirit ask him what his fame will be in a thousand years,

> "ch' è più corto
> Spazio all' eterno, ch' un muover di ciglia
> Al cerchio che più tardi in cielo è torto."
> Purg., C. xi., lines 106–108.

Also the following lines, in which our poet describes the obliquity of the ecliptic, and eloquently reminds us of the beneficial influence therefrom:—

> "Vedi come da indi si dirama
> L' obliquo cerchio che i pianeti porta,
> Per satisfare al mondo che li chiama;
> E se la strada lor fosse men torta,
> Molta virtù nel ciel sarebbe invano,
> E quasi ogni potenzia quaggiù morta."
> Par., C. x., lines 13–18.

See, also, how Dante characterises in the following lines the mighty power of the sun :—

> "Lo ministro maggior della natura,
> Che del valor del cielo il mondo imprenta,
> E col suo lume il tempo ne misura,"
> Par., C. x., lines 28–30.

It is also remarkable that the great Italian poet, differing in opinion from Aristotle ("il maestro di color che sanno"), and Ptolemy, who believed that the light of the Milky Way was caused by the density of the sky at the zone through which it passes, thought, with Democritus, that the puzzling galaxy consisted of an immense number of stars, more or less bright ; as the following lines tell us :—

> "Come, distiuta da minori e maggi
> Lumi, biancheggia tra i poli del mondo
> Galassia sì, che fa dubbiar ben saggi,"
> Par., C. xiv., lines 97–99.

And, to finish with quotations, see in the following lines how Dante held firm the true one of the many theories of the tides which were advocated in the Middle Ages :—

> "E come il volger del ciel della luna
> Cuopre e discuopre i liti senza posa,
> Così fa di Fiorenza la fortuna ;"
> Par., C. xvi., lines 82–84.

The foregoing quotations are sufficient to prove that Dante possessed a vast amount of scientific knowledge, which, in most cases, he displays most judiciously to interest his readers, and to inculcate in their minds the truths he wants to teach them. In conclusion, I beg leave to say again that if the fame of the great Italian grows in proportion with the world's civilisation, it is because he was not merely a great poet, but because he was also a great artist, a profound philosopher, an eminent astronomer, and an inspired theologian.

N. PERINI.

## *COLENSO'S MAORI DICTIONARY.*

*A Maori English Lexicon.* By the Rev. W. Colenso. (Wellington, 1898.)

MR. COLENSO'S Maori English Lexicon, being, as stated on the title-page, a comprehensive dictionary of the New Zealand tongue, including mythical, mythological, "taboo" or sacred, genealogical, proverbial, poetical, tropological, sacerdotal, incantatory, natural history, idiomatic, abbreviated, tribal and other names and terms of and allusions to persons, things, acts, and places in ancient times, also showing their affinities with cognate Polynesian dialects and foreign languages, with copious pure Maori examples, has a sad history to tell. To begin with, it is only a first instalment, going no further than *Anguta* in the Maori English part, and *to come* in the English Maori part ; nor does it seem settled even now that Mr. Colenso will be able to finish the publication of it. That such a lexicon ought to have been published by the New Zealand Government long ago, admits of no gainsaying. It is a work practically useful to the whole Colony, and who is to publish such a work if the Government declines to do so? As far back as 1861 the Rev. W. Colenso made his first proposal to the House of Representatives. His motion, he tells us, was favourably received, and the resolution was passed, "That the House considers it highly desirable that a sum of money be devoted for the purpose of commencing a Standard Library Dictionary of the Maori Language." But there followed the ominous sentence, "as soon as the finances of the Colony will permit." A new application was made in 1862, when the finances seemed to be in a flourishing state, but without results. Then came the war in 1863, and nothing was done. The Governor, Sir George Grey, took an active interest in the matter ; but in spite of that, nothing was done in 1864. At last, in 1865, an estimate was asked for, and Mr. Colenso stated that the time required would be seven years, and the expense would be 300*l*. per annum. In 1865 the House once more decided that it is highly desirable that the Maori dictionary should be commenced forthwith. Mr. Colenso then devoted himself entirely to this work, shutting himself up, as he says, fourteen and even sixteen hours a day. He gave up his official duties and his useful natural history studies, which had made his name familiar to students at home. He received, however, but scant recognition from the Government, and in 1867 it seems that an official inquiry was called for by the House, and another gentleman was appointed to inspect and report. The report was favourable, and so were some other reports in 1868. But the House seems to have grown impatient. Mr. Colenso was informed that the work must be finished by 1870, and that no more money should be paid after that date. After that, the relations between the Government and the compiler of the dictionary seem to have become strained. Unfortunately illness supervened, possibly aggravated by disappointment, for Mr. Colenso speaks of "having been goaded on to desperation almost through the remarks made in the House and the bad faith of the Government." In 1870 Mr. Colenso entered the Provincial Council again, and was appointed Inspector of Schools, so that he could devote his spare time only to the prosecution of his literary labours. A last appeal was made by Mr. Colenso in 1875, offering to hand over his materials to Government, or to go on again with his work if the Government would grant the necessary funds. To this, we are informed, no answer was returned, but transactions went on, more or less unsatisfactory, till at last the first instalment of the dictionary was sent to press, and published in 1898!

This certainly seems a sad history, and, considering Mr. Colenso's age, we can hardly hope that he will be allowed to finish this great undertaking. In the meantime two Maori dictionaries have been published by Williams and by Tregear, but on a smaller scale ; so that Mr. Colenso's work may still be very useful as filling many a gap left by his predecessors. It is difficult for an outsider to form an opinion as to the rights of the case. Scholars are sometimes dilatory, and Governments are sometimes stingy, and that on the highest principles. Personal feuds, too, are difficult to avoid when different parties divide the Government, and patronage is put into the hands of whatever party is in power.

The loss to science, particularly to linguistic studies, is very great, for by his long residence among the Maoris Mr. Colenso seemed highly qualified for the work which

he had undertaken, and which, under more favourable auspices, he might have finished by this time. On comparing some of the entries, even in this small fragment we come across several which are most interesting. It is well known that the Maoris call their gods *Atuas*. But the question is, why? It seems at first sight as if *Atua* was derived from *atu*, a particle expressive of many things. Mr. Colenso enumerates thirty-three meanings of it, one of which is an emphatic *very*, used also to form superlatives and to express extraordinary greatness, or anything that goes beyond everything else. *Atua* may have been derived from it, though it seems to convey not so much the idea of exceeding greatness as of being terrible. Hence it is used as a name of any supernatural and malevolent being, a demon, and also of their gods, many of whom were more or less malevolent. The most dreaded and powerful *Atuas* were *Tu*, *Rongo*, *Tane*, *Tangaroa*, *Tawhiri matea*, and *Whiro*, four of whom appear again as the gods of Hawaii, viz. *Tu*, *Lono* (Rongo), *Kane* (Tane), and *Kanaloa* (Tangaroa). All of these, though invoked, were hated and often threatened by their worshippers. Idols also are called *atua*, and a number of imaginary invisible evil powers, genii, spooks and gnomes, go by the same name. *Atua* is applied also to sickness, pain and death, as personified, in fact, to anything abnormal and monstrous, disgusting and disagreeable. Natives who never touch pork, eels, or even mutton, call them also *atua;* in fact, anything uncanny or unlucky is *atua*. It was unfortunate that the same word should have been taken by the missionaries as the name of the Deity, the one true God, the God of the Christians. This to the natives sounded at first like a solecism, but in the course of time it has lost its original meaning, and serves its purpose now as the name of the God of Love. Mr. Colenso would prefer *Matua*, *Matua-pai* for that purpose, though *Matua* itself is but a derivative of *Atua*.

One remark we should like to make in conclusion. Mr. Colenso generally adds Maori sentences in proof of the meaning assigned to each Maori word. But, alas! he gives no translations; and as the study of Maori has not yet been recognised in our schools and universities, much of the usefulness of these *pièces justificatives* is lost on those who consult his dictionary, however convinced they may feel that Mr. Colenso has rightly interpreted them.

## THE SPIDERS OF HUNGARY.

*Araneæ hungariæ . . . conscriptæ a Cornelio Chyzer et Ladislao Kulczyński.* Vols. i.–ii. (Budapesth: 1891–1897.)

OWING to the homogeneous character of the fauna of Central Europe, this work, although purporting to deal merely with the spiders of Hungary, forms an admirable basis for the study of the species that inhabit the rest of the continent. The determination of the species occurring in the area over which the authors' researches have extended, has of necessity involved a comparison between them and the species previously recorded from Scandinavia, Prussia, Great Britain and France by Clerck, Westring, Menge, Koch, Blackwall, Walckenaer, Simon and others. The fact that so many naturalists have worked more or less independently, sometimes indeed contemporaneously, at the spiders of their respective countries has unavoidably caused a great deal of clashing in the specific nomenclature; and the endeavour to clear away the resulting confusion certainly forms the most difficult part of the labours of an author who attempts at the present time to monograph the spiders of any area in Europe. It is evident that Dr. Chyzer and Prof. Kulczyński have in nowise shirked their duty in this respect; and although it is improbable that their efforts have met in every instance with the success they deserve, it would be unfair to lay to their charge the blame for any failures that may hereafter come to light. Rather must the responsibility rest with those of their predecessors and contemporaries who, especially when dealing with the more obscure species, have failed to realise the importance of setting aside, as a standard for future comparison, one typical example out of a series of specimens upon which a description was based, or have regarded subsequently and, as results have shown, often wrongly identified examples as of equal importance to the one upon which the species was originally established.

Of the excellence of the book as a whole the names of the authors is sufficient guarantee. A passing word of praise, however, must be bestowed upon the method in which the specific and generic diagnoses are dealt with, since it is a method which might with advantage be imitated by all systematic workers who wish to lighten the labours of those that come after them. The characters of the species and genera are set forth in tabular or synoptic form, so that they may be readily comprehended, and so that a spider of unknown affinities may be rapidly identified, even by a student unfamiliar with the taxonomic features of the family to which it belongs. Such tables, moreover, have the further advantage of inspiring confidence in the ability of an author, since they bear witness to the gift of the scientific faculty of analysis, the absence of which too often renders abortive the efforts of many a systematic zoologist.

Since the families to which the spiders enumerated belong are not diagnosed, it may be supposed that these volumes are not intended for the use of beginners, but only for those who have mastered the first principles of the classification of the Araneæ. This is, I think, an omission which somewhat impairs the value of the work. One page, or, perhaps, two pages at most, might with great advantage and but little trouble have been devoted to a tabular representation of the groups of this rank, exactly as has been done in the case of the genera and species. Unfortunately it is quite the fashion amongst arachnologists to fight shy of such a task.

Another slight blemish, in my opinion, is the adoption of such terms as Misumenoidæ and Calommatoidæ for the older and better known Thomisidæ and Atypidæ respectively. The former, and others that could be named, were introduced by Dr. Thorell for reasons that appeared inadequate to most of his contemporaries. Happily they have been recently abandoned by the author to whom they owed their existence, and but for their reappearance in the present case would by this time in all probability have dropped into merited oblivion.

This, however, is after all a matter of very little

moment, and cannot be said to affect adversely in any degree the purpose that the volumes were intended to fulfil. If to what has already been said in their favour, it is added that they are illustrated with fifteen lithographic plates containing over one thousand figures, it will be evident that Dr. Chyzer and Prof. Kulczyński have produced a work which will take rank as one of the most important contributions to our knowledge of European spiders that has appeared this century.

R. I. POCOCK.

## OUR BOOK SHELF.

*Electrodynamics: The Direct Current Motor.* By C. A. Carus-Wilson, M.A., late Professor of Electrical Engineering, McGill University, Montreal. Pp. 298. (London: Longmans, Green and Co., 1898.)

IN no department of applied science has advance in the last few years been more striking than in the application of the continuous current motor to traction purposes. This rapid advance has, however, until quite recently been rather in the United States, in Canada, and on the Continent, than in our own country. The appearance of this book by Prof. Carus-Wilson, of the McGill University, dealing with those problems which face the electrical engineer when deciding upon the choice of motors, is therefore singularly opportune.

The growth of our great towns has brought about an ever-increasing demand for rapid transit combined with frequent stoppages. In all the new schemes for underground electric railways in London an attempt is being made to combine these two opposing requirements. The starting torque or accelerating power of a motor is its most important merit from the traction engineer's point of view. Prof. Carus-Wilson lays considerable stress on the properties of series and shunt wound motors at rest before proceeding to treat of his subject in a more general way. His graphical methods of attacking the various mechanical problems are very carefully worked out, and the book is illustrated throughout by a remarkable series of very neat and clear diagrams—some theoretically obtained, and others the result of experiments on the tractive force and acceleration of actual electric locomotives.

The author makes use of many new terms, the meaning of which one does not fully appreciate on a first reading. Many expressions are used in quite an unusual sense, as, for example, "magnetisation curve," meaning a curve of distribution of magnetic flux. The term "acceleration curve" is also applied where one would be inclined to say "curve of velocity." These differences of language are, however, no doubt inseparable from the originality of the author's methods.

The book, though not a large one, is yet undoubtedly an important contribution to technical literature.

D. K. M.

*A Trip to Venus.* By John Munro. Pp. 254. (London: Jarrold and Sons, 1897.)

THE apparent similarity between the physical conditions of the planet Mars and those which exist upon the earth have furnished several writers with material upon which to exercise their imaginations. Many considerations point, however, to the earth's twin sister, Venus, as possessing conditions of habitability more closely resembling those enjoyed by us than would be found on Mars, which fact has given Mr. Munro a text for this novel.

The prescription for a story on extra-terrestrial affairs appears to contain as essential constituents a description of a flying machine in which "a new force" is utilised, a modicum of astronomical information, a few sentimental episodes, and some representations of wonderful forms of organic life observed in the "other world" with which the narrative is concerned. Mr. Munro departs but very slightly from this formula. The actors in his little drama are a gentleman who represents the mind of the average man and tells the story, an astronomer who speaks like a text-book, an inventor who constructs a flying machine of marvellous efficiency, and a young lady whose presence naturally introduces into the narrative the vein of sentiment without which no novel is complete. This is the company which makes the trip to Venus and Mercury, and brings back information as to the inhabitants of those planets and on various other objects and phenomena which, unfortunately, astronomers have to actually observe from the bottom of a restless atmospheric sea.

It is perhaps a doubtful compliment to say that a work of fiction is instructive, but we cannot resist paying it in the present case. As a story Mr. Munro's novel is but of indifferent quality, but as a series of short disquisitions upon astronomical matters, more or less worked into a narrative, the book is worth reading, especially as it possesses the merit of correctness so far as it goes.

The idea of the supposed inhabitants of Mars signalling to the earth by burning different elements, which are subjected to spectroscopic analysis by the astronomer of the party, is noteworthy, and it is a pity that the author did not make more of it. The description of the meeting of the Royal Astronomical Society, given in the last chapter, is a disappointing and unnecessary epilogue of the story.

*A Dictionary of Bird Notes, &c.* By C. L. Hett. Pp. 138. (Brigg: Jackson, 1898.)

THIS little volume is obviously intended for the field-observer, being bound with the corners rounded off and blank pages for notes opposite the pages of letter-press. The author has secured the co-operation of a number of fellow bird-lovers; and their joint labours have resulted in the production of a syllabic reproduction of the notes of every British bird, which it may be hoped will prove satisfactory not only to themselves but to ornithologists in general. Judging from his preface, the author himself appears to be confident that he has achieved complete success, but we fear that many persons would require a supplemental education before they are capable of appreciating the merits of his scheme. The correctness of many of the notes are self-apparent, but some are decidedly difficult of pronunciation by the uninitiated, and it is to be hoped that many of his readers are unfamiliar with the precise tone of "the snore of a drunken man," which is given as one of the notes of the chaffinch.

The glossary of popular, local, and old-fashioned names of British birds, which forms one of the appendices, will certainly prove useful to young ornithologists dwelling in the provinces, and may sometimes even be a help to their more experienced brethren.

R. L.

*Chemical Analysis, Qualitative and Quantitative.* By W. Briggs, M.A., and R. W. Stewart, D.Sc. Pp. x + 128. (London: W. B. Clive.)

THE pupil who uses this book ought to obtain an intelligent grasp of the principles of chemical analysis. A chapter on simple experiments in manipulation leads to chapters on the reactions of the various groups of metals and the acids, and these are followed by instructions for systematic analysis, analysis of mixtures, and volumetric work. The instructions are clear and concise, but, as might be expected from the nature of the subject, the book departs but little from the style of others of the same kind.

## LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### Potential Matter.—A Holiday Dream.

WHEN the year's work is over and all sense of responsibility has left us, who has not occasionally set his fancy free to dream about the unknown, perhaps the unknowable? And what should more frequently cross our dreams than what is so persistently before us in our serious moments of consciousness—the universal law of gravitation. We can leave our spectroscopes and magnets at home, but we cannot fly from the mysterious force which causes the rain-drops to fall from the clouds, and our children to tumble down the staircase. What is gravity? We teach our students to accept the fact and not to trouble about its cause—most excellent advice—but this is vacation time, and we are not restricted to lecture-room science.

Lasage's particles are not satisfactory; they are too materialistic for the holiday mind; but I have always been fascinated by a passage occurring somewhere in Maxwell's writings, where Lord Kelvin is quoted as having pointed out that two sources or two sinks of incompressible liquid will attract each other with the orthodox distance law.

Let us dream, then, of a world in which atoms are sources through which an invisible fluid is pouring into three-dimensioned space. What becomes of this fluid? Does it go on for ever increasing the volume of that all-pervading medium which already fills a vast, but not necessarily infinite, space? When we speak of the constancy of matter, we mean only the constancy of inertia, and how are we to prove that what we call matter is not an endless stream, constantly renewing itself and pushing forward the boundaries of our universe? The conception of atoms as sources of fluid does not, however, necessarily involve such a perpetual increase of substance, for an equal number of sinks may keep withdrawing the increment.

These sinks would form another set of atoms, possibly equal to our own in all respects but one; they would mutually gravitate towards each other, but be repelled from the matter which we deal with on this earth. If matter is essentially dynamical, and we imagine the motion within an atom to be reversed, the question arises whether the reversed motion is similar to the original one; in other words, whether the new atom so formed may by a change of position be brought into coincidence with the old one. And if this is not the case, we must ask ourselves whether the new atom will behave gravitationally like the old one. If atoms are sources of liquid there would be no reciprocity, and the sinks would form another and so far unrecognised world. But sources and sinks compel us to the supposition of a fourth dimension, which belongs to the domain of nightmares, not of dreams, and we try to shake ourselves free from the idea.

I, for one, cannot quite succeed in this effort, for something has been left behind, which is not easily got rid of, when once its symmetrical beauty is perceived. Surely something is wanting in our conception of the universe. We know positive and negative electricity, north and south magnetism, and why not some extra terrestrial matter related to terrestrial matter as the source is to the sink, gravitating towards its own kind, but driven away from the substances of which the solar system is composed. Worlds may have formed of this stuff, with elements and compounds possessing identical properties with our own, undistinguishable in fact from them until they are brought into each other's vicinity. If there is negative electricity, why not negative gold, as yellow and valuable as our own, with the same boiling point and identical spectral lines; different only in so far that if brought down to us it would rise up into space with an acceleration of 981. The fact that we are not acquainted with such matter does not prove its non-existence; for if it ever existed on our earth, it would long have been repelled by it and expelled from it. Some day we may detect a mutual repulsion between different star groups, and obtain a sound footing for what at present is only a random flight of the imagination.

Even now some might argue that we possess some substantial evidence of repulsive forces. In our glorification of the Newtonian system we are apt to overlook some obvious facts which the law of gravitation fails to explain. One of these is the rotational velocity of our solar and of many stellar systems, which cannot be self-generated. Unless we threw our laws of dynamics overboard, or imagine the rotation to have been impressed by creation, we must conclude that some outside body or system of bodies is endowed with an equal and opposite angular momentum. What has become of that outside body, and how could it have parted company with our solar system, if attractive forces only were acting? Another unexplained fact is found in the large velocities of some of the fixed stars, which, according to Prof. Newcomb's calculations, cannot be explained by gravitational attractions only.

The atom and the anti-atom may enter into chemical combination, because at small distances molecular forces would overpower gravitational repulsions. Large tracts of space might thus be filled unknown to us with a substance in which gravity is practically non-existent, until by some accidental cause, such as a meteorite flying through it, unstable equilibrium is established, the matter collecting on one side, the anti-matter on the other until two worlds are formed separating from each other, never to unite again.

Matter and anti-matter may further coexist in bodies of small mass. Such compound mixtures flying hither and thither through space, coming during their journey into the sphere of influence of our sun, would exhibit a curious phenomenon. The matter circulating in a comet's orbit, the anti-matter repelled and thrown back into space, forming an appendage which is always directed away from the sun. Has any one yet given a satisfying explanation of comets' tails; is the cause of coronal streamers known, and can any one look at a picture of the great prominence of the 1885 eclipse, and still believe that gravitational attraction or electric repulsion is sufficient to account for its extravagant shape? But this is not a scientific discussion. I do not wish to argue in favour of the existence of anti-atoms, but only to give my thoughts a free course in the contemplation of its possibility.

What is inertia? When the atom and anti-atom unite, is it gravity only that is neutralised, or inertia also? May there not be, in fact, potential matter as well as potential energy? And if that is the case, can we imagine a vast expanse, without motion or mass, filled with this primordial mixture, which we cannot call a substance because it possesses none of the attributes which characterise matter ready to be called into life by the creative spark? Was this the beginning of the world? Is our much-exalted axiom of the constancy of mass an illusion based on the limited experience of our immediate surroundings? Whether such thoughts are ridiculed as the inspirations of madness, or allowed to be the serious possibilities of a future science, they add renewed interest to the careful examination of the incipient worlds which our telescopes have revealed to us. Astronomy, the oldest and yet most juvenile of sciences, may still have some surprises in store. May anti-matter be commended to its care! But I must stop—the holidays are nearing their end—the British Association is looming in the distance; we must return to sober science, and dreams must go to sleep till next year.

Do dreams ever come true? ARTHUR SCHUSTER.

### Live Frog taken out of a Snake.

YOUR correspondent, Colonel Major, may be interested to hear of another instance of a Batrachian returning alive from the stomach of a snake. A grass snake of about 24 inches, kept in captivity, had not fed for three weeks: it was then given a very large specimen of the common frog, full-grown; this was swallowed at once, in the usual way by taking the hind leg first. In about an hour and a half the frog was a third of the way down the snake's body. Then, on the snake being played with and handled, after some minutes the lump began to move up rapidly towards the head of the snake, the mouth opened and out slid the frog; rather off colour, and not very happy-looking, but quite able to hop about in a shuffling fashion, though decidedly shaky on his legs. To an amphibian imprisonment without air could not be very hurtful for a few hours, were it not for the poison of the gastric juices. When the grass snake was left again with the frog it re-swallowed its prey. A snake will often take half an hour swallowing a frog: the distension of the jaws during the operation is extraordinary to witness. In about an hour's time the frog will be a third of the way down the snake's body. ROSE HAIG THOMAS.

Badenweiler, August 14.

IN the spring of 1885, at Divonne-les-Bains, I killed a snake, and on cutting it open I found one frog slightly decomposed and another frog apparently dead; the latter recovered in about a quarter of an hour, and hopped away. H. LING ROTH.

32 Prescot Street, Halifax, August 12.

### Dogmatism on the Moon and the Weather.

IN a recent little book, "The Story of the Weather," by G. F. Chambers, I have come across one of those *ex cathedrâ* statements which, I think, illustrate the curious disposition of the mind (even the scientific mind) to circumscribe and limit truth. "No one in his senses," our Meteorological Office is quoted as saying, "can believe in the moon's influence on the weather." Is the matter, then, clear as noonday, or as an axiom of mathematics? Supposing we have, thus far, no proof of such influence, how can we possibly be certain that no such influence exists, or will ever be demonstrated? I happen to be, unfortunately, one of those "lunatics"; but I rather think I am in good company. The author of the book himself, oddly enough, just before approving, apparently, the above dictum, expresses his firm conviction (p. 197) that the full moon scatters clouds! (a point, however, which I cannot say I have studied).

A. B. M.

### Rules for Compositors and Readers.

IN the *British Printer* for May and June of last year appears an article under the above heading, by Mr. Horace Hart, Controller, Clarendon Press, Oxford, which, as in my case, may have escaped the notice of some of your readers. On this assumption it would be as well, taking into consideration the importance of the matter to scientific men generally and directors of museums in particular, to ask for the views of others qualified to judge upon the advisability of discarding the use of the digraphs œ and æ in Greek words written in English characters, in Latin words, and—presumably—in words derived therefrom, such as Coelenterata and Caesarean, which, according to Mr. Hart, should not be written, as they usually are, Cœlenterata and Cæsarean. The importance of such a ruling cannot be over-estimated in any museum which desires to teach and not mislead its students—to say nothing of the waste of elaborate labels which the disuse of the digraphs entails, and these considerations must be my excuse for troubling your technical readers for their opinions.

Leicester. MONTAGU BROWNE.

## "ARTIFICIAL FOOD."

UNDER the above title the *Daily Chronicle* of Friday, August 5, prints a telegram from its Vienna correspondent announcing the synthetic preparation, by Dr. Leon Lilienfeld, of albumen having "absolutely the same nourishing qualities as found in that which is obtained from organic beings." Such a synthesis would undoubtedly mark an epoch both in chemistry and physiology, but unfortunately for those who have attached undue importance to Dr. Lilienfeld's announcement, the data given in the sensational telegrams, if correct, were sufficient to show that, whatever he might have achieved he had certainly not obtained the substance commonly known as albumen. It is enough to point out that with the materials employed, the artificial product could not contain sulphur, which, at any rate up to the present, is regarded as an essential constituent of albumen.

The report of the International Congress of Applied Chemistry, given in the number of the *Chemiker Zeitung* (xxii. 644) just to hand, includes a short account of Dr. Lilienfeld's paper. Translated it runs:—

"Dr. Lilienfeld gave a very interesting account of the artificial synthesis of albuminous substances (*Eiweisskörper*). It has been found possible to prepare pepton hydrochloride by the condensation of phenol and glycocoll with phosphoric oxychloride; thus obtained, it gives all the reactions of the albuminoids. The lecturer experimentally demonstrated the preparation and properties of the new compound. By previous conversion into the sulphate and decomposition of the latter, the free pepton can be obtained, and resembles, both in its chemical and physiological behaviour, the natural pepton from albumen. The analytical data corresponded with those given by natural pepton."

From this it is evident that Dr. Lilienfeld claims not the synthesis of albumen, but that of pepton, a digestion product of albumen, which, in spite of the statements of Henninger and others, does not seem so far to have been reconverted to its parent substance. In the absence of exact details, it is impossible to say how far the claim to the synthesis of pepton is justified, but it may be as well to recall previous work in the same direction.

Grimaux published in the *Comptes rendus*, about fourteen years ago, several papers on the formation of colloids from inorganic materials. Among others he obtained two: (1) by heating meta-amidobenzoic acid with phosphorus pentachloride, and (2) by the action of ammonia on solid aspartic anhydride heated at 170°. Although it was not to be expected that albumen would be obtained from such materials, it is remarkable how close was the resemblance between these colloids and the proteids when judged solely by their reactions.

A little later Schützenberger attempted the synthesis of proteids from the products of their decomposition. He had been engaged for some years on the study of the products of the hydrolytic decomposition of albumen by barium hydrate solution at varying temperatures. Among the substances obtained were various amido-acids of both the fatty and the aromatic series. He therefore dehydrated a mixture of these acids and urea with phosphoric anhydride, hoping thus to reverse the hydration process. Without giving details of the method employed, it is sufficient to say that he obtained a colloid which gave the reactions usually considered diagnostic of a proteid.

In 1897 Dr. J. W. Pickering (in continuation of a series of papers published in conjunction with Prof. Halliburton in the *Journal of Physiology*) contributed an interesting paper to the Royal Society's *Proceedings* (NATURE, 1897, 341), in which, besides confirming Grimaux's results, he added many valuable observations of his own. Among the most remarkable of these is the fact that the colloid obtained from aspartic anhydride is digested by pepsin-hydrochloric acid, and then gives the colour reactions for pepton, and, further, that it closely resembles the nucleo-proteids in its physiological action.

Dr. Pickering, moreover, greatly extended Grimaux's work, and prepared several new colloids, such as one from a mixture of tyrosine, biuret, and phosphorus pentachloride, a second from para-amidobenzoic acid and phosphorus pentachloride, and a third from alloxan, meta-amidobenzoic acid and phosphoric anhydride. These, together with several others, gave the reactions of the proteids, coagulated at definite temperatures, and produced intravascular coagulation of the blood. Still more noteworthy is the fact that according to the author they are optically active, like the natural proteids. Should this statement be confirmed, these would be the first optically active substances produced directly from inactive materials. As this feat has hitherto been regarded by chemists as improbable, if not impossible, these colloids are certainly worthy of closer investigation from this point of view.

Dr. Lilienfeld, too, has synthesised a substance giving the reactions of a proteid by condensation of a base which he called biuretdimethylene, with different amido-acids. It should, however, be noted that these workers, so far, have not claimed that the products obtained were actually proteids, but only that they bore a striking resemblance to them; and in this they were doubtless correct.

It is well known that the so-called "tests" applied to the detection of a proteid are purely empirical. Such

colour tests as Millon's, nitric acid, &c., have no real value; the colour developed *may* be due to the proteid molecule as a whole, but more probably to some decomposition product, and, as already mentioned, some colloids which bear no relation to actual proteids give reactions considered characteristic of these substances. Again, the peptons in their reactions strangely recall the alkaloids, especially in the precipitates they give with mercuric chloride, potassium periodide, phosphotungstic and phosphomolybdic acids, &c., while elementary analysis is of little value, as all the proteids give very similar figures, which in nowise indicate the striking differences met with in their physiological behaviour. When, in addition, it is remembered how extremely complex and mobile the proteid molecule must of necessity be, and the readiness with which changes in its constitution are brought about, something more than a few empirical colour and physiological tests will be required to convince chemists that pepton has been actually synthesised. Dr. Lilienfeld's results evidently need further investigation, and in the meantime the question raised by his announcement is distinctly one that calls for suspended judgment.

SIDNEY WILLIAMSON.

## THE TOXICITY OF EEL-SERUM, AND FURTHER STUDIES ON IMMUNITY.

THE investigation of poisons, both bacterial and animal, has been pursued with such enthusiasm in so many parts of the world during the past decade, and the public have been brought into such close touch with some of the practical applications which have followed in the track of these investigations, that the term toxin and anti-toxin, unknown in the days of Dr. Johnson's colossal dictionary, may now without exaggeration be said to form part of the vocabulary of every well-ordered household.

But whilst the more striking beneficent results obtained in the study of immunity have become public property, so to speak, a mass of important and most interesting researches remain concealed from the layman's view, locked away, as far as he is concerned, in the pages of divers scientific journals.

Of such researches we may cite those which have relegated the blood-serum of eels to the category of poisons. This remarkable discovery was made as long ago as the year 1888 by A. Mosso,[1] of Turin, who found that the serum of eels, when subcutaneously and intravenously inoculated into animals produced fatal results, although it was quite harmless when introduced *per os*. Half a cubic centimetre of eel-serum inoculated into a dog weighing 14 lbs. killed the animal in seven minutes; and Mosso obtained similarly lethal results in the case of rabbits, guinea-pigs, frogs, and pigeons.

But little further attention appears to have been paid to this subject until Calmette,[2] in 1895, and Phisalix,[3] in 1896, carried out further experiments on the toxic character of such serum from an immunising point of view, and this year we have had quite a crop of memoirs on eel-serum treated from various sides, and our information is consequently greatly extended concerning both the character of this poison and its antidote.

It appears that the toxic effect of this eel-serum varies according to the manner in which it is introduced into an animal, and the different quantities required to produce lethal subcutaneous, intravenous, and intraperitoneal inoculations respectively have been elaborately determined by Maglieri,[4] who states that for every 2-lb. weight of

[1] *Archives Italiennes de Biologie*, vol. x., 1888.
[2] "Venins, toxines et sérums antitoxiques" (*Annales de l'Institut Pasteur*, vol. ix., 1895).
[3] *Comptes rendus de l'Académie des sciences*, 1896.
[4] "Sull'azione tossica immunizzante e battericida del siero di sangue di anguilla." (*Annali d'Igiene Sperimentale*, 1897.)

rabbit employed from ·02 to ·025 c.c. of serum is required in intravenous inoculations, ·4 to ·45 c.c. in subcutaneous inoculations, and ·20 to ·25 c.c. in intraperitoneal inoculations. Héricourt and Richet[1] mention that in their experiments ·1 c.c. intravenously introduced was fixed as the lethal dose of serum for a rabbit weighing 4 lbs.

Wehrmann,[2] however, remarks that it is in reality very difficult to lay down a general law as to the exact quantity of this serum which will constitute a fatal dose, for it not only varies in toxic strength at different times of the year, but in eels of different origin; and it is, therefore, necessary to determine the toxic value of such serum each time a fresh supply is collected.

Before passing on to the experiments which have been carried out on modifying the lethal activity of this eel-serum, and on artificially protecting animals from its toxic action, we may refer to some interesting investigations made by Maglieri (*loc. cit.*) to ascertain whether such serum is endowed with any bactericidal properties. For this purpose tubes containing eel-serum were inoculated with colon bacilli (*B. coli communis*), cholera vibrios, and dipththeria bacilli respectively; after different intervals of time, varying from fifteen minutes up to twenty-four hours, gelatine and broth tubes were inoculated from all the serum-tubes. In every case a positive result was obtained; that is to say, growths of the three different microbes employed subsequently appeared in all the gelatine and broth tubes, indicating that, however lethal this eel-serum may be in regard to animal life, these minute vegetables—or, at any rate, the three varieties above mentioned—enjoy a natural immunity from its toxic action.

The quantity of blood which is procurable from even a large eel weighing about 5 lbs. is very small, never more than 25 cubic centimetres, and this only yields from 10 to 12 c.c. of serum, whilst in the case of vipers a relatively large quantity of blood is obtained. This eel-serum, according to Wehrmann, can be kept in a fit experimental condition for two weeks if stored over ice and in the dark, but Maglieri states that its toxicity declines gradually after the eighth day of its collection even when protected from light.

As regards the artificial modification of the lethal properties of eel-serum, U. Mosso,[3] a brother of the Mosso already referred to, mentions, amongst other devices, that heating the serum to from 68° to 78° C. removed its toxic character. Phisalix (*loc. cit.*) also found that heating it to 58° C. for a quarter of an hour destroyed its toxicity, and that such heated serum was capable of endowing animals with immunity towards ordinary eel-serum, this immunity being, however, of a very transitory character. Wehrmann found that exposing it to this temperature for a quarter of an hour removed the greater portion of its toxic powers, and when animals were inoculated with serum thus treated, a somnolent state, sometimes accompanied by a depression of temperature, followed, but that they recovered their normal condition at the end of from two to three hours, having meanwhile acquired a certain degree of immunity from the effect of ordinary eel-serum inoculations, which was retained for three days. Maglieri found that preserving eel-serum at a constant temperature of only 37° C. for the space of twenty-four hours was sufficient to greatly modify its toxicity. Very interesting is the observation recorded by Wehrmann that by subcutaneously inoculating anti-venomous serum[4] into eels the toxicity of their blood is considerably reduced. Thus an eel weighing about half a pound was inoculated with 5 cubic

[1] *Comptes rendus de la Société de Biologie*, 1897.
[2] "Recherches sur les propriétés toxiques et antitoxiques du sang et de la bile des Anguilles et des Vipères" (*Annales de l'Institut Pasteur*, p. 810, 1897.)
[3] *Archives Italiennes de Biologie*, 1889.
[4] Serum derived from an animal rendered artificially immune to the poisonous action of snake-venom.

centimetres of anti-venomous serum, after twenty-four hours it was killed, and instead of ·2 c.c. of serum sufficing to kill as usual a guinea-pig, ·4 c.c. of this particular eel's serum was required.

In this connection we may quote an observation of Calmette's,[1] made in the course of his classical experiments on the toxic character of the blood of venomous serpents, that the toxicity of the blood of such reptiles may be entirely removed by inoculating them with anti-venomous serum. Thus a large specimen of the *naja tripudians* received a series of anti-venomous serum inoculations, and two weeks after the last inoculation it was killed, and its blood was found to have lost all its toxic character,[2] whilst that of another untreated *naja tripudians* exhibited its customary complement of lethal qualities.

It would be interesting to determine in the case of eels and vipers the relative quantity of anti-venomous serum which is required to remove the toxicity of their blood respectively, for, curiously, the blood of eels is three times more toxic than that of vipers; and whilst the blood of eels acts as a preventive, protecting an animal from the lethal action of vipers' blood, the latter has no corresponding power to protect an animal from the fatal effect of eels' blood.

Of great interest are the numerous investigations which have been carried out by Wehrmann to ascertain the action of various other serums as well as biles of different origin upon this eel-serum. Anti-venomous serum, it appears, acts as an antitoxin towards eel-serum, for it not only protects animals from a subsequent otherwise fatal dose of eel-serum, but if administered even *after* the eel-serum has been introduced into the animal, it nullifies its effect, and the animal lives, whilst it also neutralises the action of eel-serum outside the animal's body *in vitro*. Different varieties of serum did not, however, all operate as successfully as anti-venomous serum. For example, anti-tetanic serum produced no effect upon the toxicity of eel-serum; neither did the normal serums of horses and rabbits. Anti-diphtheritic serum, on the other hand, acted as a preventive, and also neutralised the toxicity of eel-serum *in vitro*, but was not endowed with any curative power in respect to its toxic action.

Wehrmann has next studied the effect produced by bile derived from eels, from oxen, and from vipers, not only on the toxicity of eel-serum, but also on that of viper-serum and viper-venom. Now Fraser (*British Medical Journal*, July 1897) has recently asserted that the bile of serpents and other animals is antitoxic as regards serpent-venom, that it not only has a neutralising action *in vitro*, but that it has also a distinct, although feebly marked, *curative* power in respect to this venom. Fraser mentions the interesting fact, in support of his observations, that in some countries the natives have a practice of administering the bile of a serpent to people who have been very badly bitten by poisonous snakes.

According to Wehrmann, viper-bile has a preventive as well as neutralising action with respect to viper-venom; but he does not say that he has found it to possess, as Fraser has done, a *curative* power. This viper-bile has also a preventive and neutralising action as regards the toxic properties of viper-serum and eel-serum.

Ox-bile, on the other hand, was found to possess no antitoxic action in the doses employed by Wehrmann on viper-venom, neither was it endowed with any preventive or curative powers in respect to eel-serum.

Eel-bile, again, was devoid of all preventive or curative powers in regard to eel-serum and to viper-venom. It was able to neutralise the toxicity of both these toxins *in vitro*, and had a greater degree of neutralising power in respect to the venom than to the eel-serum. Thus, according to Wehrmann, the biles he has employed are not endowed with strictly antitoxic powers, as was claimed for serpent-bile by Fraser, but act apparently as a digestive more than anything else upon the serums and venoms with which they are mixed.

We now come to the experiments which have been carried out on the artificial production of immunity in animals from the toxic action of eel-serum.

Although heated eel-serum can afford protection to animals, yet immunity thus acquired, as we have already seen, is of so temporary a character that this method is not, as a rule, employed. The plan usually adopted by investigators consists in inoculating increasingly large doses, either intraperitoneally or intravenously, of ordinary eel-serum into the animal it is desired to render immune. By this means Maglieri and Wehrmann have both succeeded in immunising rabbits against the effects of ten, twelve, up to twenty (Maglieri) otherwise fatal doses of toxic eel-serum. The period over which the treatment has to be extended is somewhat lengthy before the requisite stage of immunity is reached. Thus, about three months must elapse before a rabbit's serum has acquired the degree of protective power to render it of use for experimental purposes. Héricourt and Richet have succeeded also in immunising a dog against eel-serum, and have obtained a protective serum from this animal.

According to Wehrmann, the serum of a rabbit immunised against eel-serum acts both as a preventive and curative with regard to the serum of vipers, and to the serum of eels, as well as to the *venom* of vipers. This observation supports the opinion frequently expressed by Calmette in his memoirs, that the idea of the specific character of toxins and their antitoxins is not justified by experiment; that, on the contrary, the serums of animals immunised against one poison may be, and frequently are, curative as regards other poisons.

It will be remembered, however, that Calmette's assertion, that the serum of an animal which had attained a high degree of immunity against cobra venom was equally valuable as a remedy against the poison of *all* snakes, has not been supported by other observers; for as regards the venom of the Indian daboia, for example, Cunningham,[1] of Calcutta, has found that Calmette's serum is inoperative, and therefore useless.

C. J. Martin, of Melbourne,[2] has still more recently tested Calmette's serum for antidotal action in the case of the venom of the tiger snake (*Hoplocephalus curtus*) and the venom of the black snake (*Pseudechis porphyriacus*), and in the matter of both these venoms he obtained no antidotal action with Calmette's serum.

Some interesting experiments were also made by Martin to ascertain if Calmette's serum possessed antidotal action in respect to one of the two proteid constituents to which, according to Mitchell and Reichert,[3] the venoms of snakes are supposed to owe their poisonous properties. Apparently, if the serum is introduced under the most advantageous circumstances, *i.e.* injected in considerable quantities directly into the circulation before the poison (in this case *one* of the proteids separated out from the venom of the Australian tiger snake is inoculated), the serum exhibits decided protective properties; but the immunity thus produced is so slight, that Martin is of opinion that it is practically valueless as a remedial agent, even against one only of the poisonous

[1] "Contributions a l'étude des venins des toxines et des serums antitoxiques." (*Annales de l'Institut Pasteur*, vol. ix., 1895.)

[2] The toxic properties of the *venom* of this *naja tripudians* were not in any way affected, indicating, as Calmette points out, that the lethal principle of which the venom consists is not elaborated in the blood, but in the cells of the venom glands of poisonous reptiles.

[1] "Scientific Memoirs, by Medical Officers of the Army of India," vol. ix., 1895.

[2] "The Curative Value of Calmette's Anti-Venomous Serum in the Treatment of Inoculations with the Poisons of Australian Snakes" (*Intercolonial Medical Journal of Australasia*, August 1897).

[3] "Researches upon the Venoms of Poisonous Serpents" ("Smithsonian Contribution to Knowledge," vol. xxvi., 1886).

constituents of this venom. It is only just to Calmette to add that Martin's criticism, of course, only applies to the serum as he was able to obtain it as imported into Australia; and Martin himself is careful to add that the specimens he had access to were only possessed of very feeble powers.

Wehrmann's valuable memoir, to which we so frequently have referred in the foregoing brief *résumé* of some of the latest contributions to the ever-increasing domain of preventive medicine, is a record of experiments carried out under the inspiration of Calmette in the Institut Pasteur at Lille. It is full of experimental data, and no attempt is made to formulate theories on the facts recorded, only at the close the following suggestion is to be found:—"Enfin nous voyons que les sérums des animaux immunisés contre l'un quelconque des poisons que nous avous étudiés sout fréquemment curatifs à l'égard des autres.

"Ces phénomènes d'action réciproque préventive, neutralisante *in vitro* et curative, apportent un argument de plus en faveur de la théorie cellulaire de l'immunité. . . . Il faut bien en conclure que la notion de spécificité des toxines et des sérums antitoxiques est loin d'être aussi étroite qu'on l'avait cru jusqu'à ces derniers temps."

G. C. FRANKLAND.

## THE RECENT PERSEID METEORIC SHOWER.

THIS display appears to have been of rather a special character on August 11, and to have attracted a considerable amount of attention. At any rate, during the thirty years in which I have witnessed returns of the shower, I have never known it to have been so generally observed. Many people, quite unaware that such a phenomenon was in progress, on looking up and admiring the singular beauty of the night, noticed the meteors. They were so numerous and occasionally so brilliant that they were watched for a considerable time.

Usually the maximum of the shower occurs on August 10, but on that date the atmosphere was, on the whole, unfavourable this year, and at the majority of stations not many Perseids appear to have been observed. The following evening came in under vastly improved conditions, the stars shone with remarkable lucidity, and it was quite an ideal night for the observation of meteors. To this circumstance, and to the fact that the shower was really a strong one, perhaps coming a little later than usual, is to be ascribed its marked prominence.

In the twilight at 8h. 58m. a splendid meteor brighter than Jupiter was seen in the S.S.W. sky, moving very slowly and almost horizontally westwards amongst the stars of Ophiuchus and Serpens. It threw off a thick train of yellow sparks, but, when near $\epsilon$ Serpentis, the nucleus, after a sudden accession of brilliancy, collapsed, and I thought the whole thing had vanished until, in the same direction of motion, a star-like fragment became visible and travelled some 8° further. It moved very much slower than the earlier and brighter part of the meteor had done, and looked like a mere spark sailing along on the wind. This meteor was also observed at Slough and other places, and it will be possible to obtain some interesting deductions respecting it. It was manifestly not a Perseid; its leisurely flight being directed from the region of Pisces and Aquarius.

At 10 p.m. I began watching the eastern sky, and immediately found that the Perseids, with their swift motions and phosphorescent streaks, were in strong evidence. During the 4½ hours ending 2.30 a.m. on August 12 I saw 106 of them, but I believe that a continuous watch of the sky would have enabled twice this number to have been counted. Whenever bright meteors appeared, or others were observed with great exactness, they were carefully registered; and during these intervals, when attention was distracted from the sky, many Perseids must have escaped my notice. I think that one observer might have counted quite 50 meteors per hour in an uninterrupted view of the sky on the night of August 11.

I endeavoured to ascertain the position of the radiant point as precisely as possible, and obtained it at hourly intervals from the best observed paths in the region immediately surrounding it. The results were as follow:—

| | h. h. | | Radiant. | | |
|---|---|---|---|---|---|
| Aug. 11, | 10 to 11 | ... | 47° + 58° | ... | 21 meteors |
| ,, | 11 to 12 | ... | 46½ + 58 | ... | 22 ,, |
| ,, | 12 to 13 | ... | 46 + 57 | ... | 20 ,, |
| ,, | 13 to 14 | ... | 46 + 57½ | ... | 18 ,, |

The mean is at 46°·4 + 57°·6, which I believe is well within 1° of probable error. The centre was defined with tolerable sharpness, for all the registered paths intersect within an area of about 4° diameter.

Some conspicuous meteors were observed during the night, though no really large fireballs appeared. It may be advisable to give the apparent courses of the brighter objects, for some of them must certainly have been seen by other observers, many of whom were watching the sky on the same night.

| G.M.T. h. m. | Mag. | Path From | Path To | Length of path. |
|---|---|---|---|---|
| 8 58 | > ♃ | 259° − 2° | 231° − 1¼° | 28° |
| 10 9 | 1 | 56 +64 | 65 +67 | 5 |
| 10 16 | ♃ | 200 +61½ | 206 +44½ | 17 |
| 10 45 | ♃ | 240½ + 62½ | 237 +47 | 15½ |
| 10 49 | 1 | 37½ + 66 | 30 +70½ | 5 |
| 10 57 | > 1 | 21 +26 | 16 +11¼ | 15½ |
| 11 12 | 1 | 359 +78½ | 295½ +77¼ | 13 |
| 11 26 | > 1 | 12½ + 15 | 7 + 0½ | 15½ |
| 11 35 | 1 | 50 +67 | 54 +71 | 4½ |
| 12 15½ | 1 | 27¾ +37 | 25 +30½ | 7 |
| 12 19½ | 1 | 2½ + 57½ | 348 +54 | 9 |
| 12 23½ | ♃ | 14½ + 29 | 6 +13 | 17½ |
| 12 39 | 1 | 13½ + 19 | 9 + 8 | 12 |
| 13 11 | ♃ | 20½ + 1 | 18 −11 | 12½ |
| 13 29 | > 1 | 46 +31 | 46 +19 | 12 |

With the exception of the first, all these were Perseids.

It is satisfactory to note that reports from other quarters show that the display was very successfully observed. Prof. Herschel, at Slough, describes the rate of appearance and general brightness of the meteors on the night of August 11 as considerably greater than on other dates, and mentions having mapped 80 observed paths between 10½h. and 14h. Four of the Perseids observed at Bristol were also recorded by him at Slough, and he finds their radiants very definitely and distinctly marked at about 46° + 58°.

At Paris, it appears that very favourable conditions prevailed on August 10, so that Mlle. Klumpe, at the Observatory, succeeded in observing 200 shooting stars. The display is stated to have begun at sunset and to have continued with "amazing rapidity" until sunrise. It is estimated that altogether at least 600 shooting stars were noticed.

W. F. DENNING.

## NOTES.

THE proposal made at the Toronto meeting of the British Association last year, for a marine biological station in the Dominion of Canada, is taking practical shape. Such a proposal has been in the minds of Canadian biologists for many years, and Prof. Prince, the Dominion Commissioner of Fisheries, reported at length upon the necessity for such a marine station for Canada in the Marine and Fisheries Blue Book, 1894, and the Royal Society of Canada also urged the

importance of the matter; but it was not until the British Association appointed a Committee consisting of Prof. E. E. Prince (Ottawa), Chairman; Prof. Penhallow (Montreal), Secretary; and Prof. A. B. Macullum (Toronto), Prof. John Macoun (Ottawa), Prof. Wesley Mills (Montreal), Prof. E. W. MacBride (Montreal), and Dr. W. T. Thiselton-Dyer, that active steps were taken to carry out the scheme. An influential deputation waited upon the Hon. Sir Louis Davies, Minister of Marine and Fisheries, in April last, and during the recent session of the Canadian Parliament a vote of 3000*l.* was practically sanctioned, 1400*l.* being granted for the year 1898–99. A Board of Management has been chosen as follows: Prof. E. E. Prince (nominated by Sir Louis Davies to represent the Department of Marine and Fisheries) to act as Director, Profs. Penhallow, MacBride (McGill University), Ramsey Wright (Toronto University), L. H. Bailey (New Brunswick University), Rev. F. A. Huart (Laval University, Quebec), and members from Queen's University, Kingston and Dalhousie University, Halifax, Nova Scotia.

IN the death, on August 7, of Prof. James Hall, of Albany, the United States loses its most distinguished geologist at the ripe age of eighty-seven. Born at Hingham, Massachusetts, on September 12, 1811, James Hall became attached to the study of natural history in early life, and gained much instruction at the Polytechnic Institute at Troy. In 1836 he was appointed one of the geologists on the Cadastral Survey of the State of New York, and was charged later on with the palæontological work. Eventually he became State Geologist and Director of the Museum of Natural History at Albany. His published papers date from 1836, and he is the author of numerous reports on the geology and palæontology of various portions of the United States and Canada. His chief work has been the description of the invertebrate fossils of New York, a work comprising eight quarto volumes published 1847–94. Forty years ago he was awarded the Wollaston Medal by the Council of the Geological Society of London, and it was then pointed out how he had shown that the organic remains of the earliest rocks in America bore strong resemblance to those of this country. Ten years previously (1848), he had been elected a Foreign Member of the same Society. Prof. Hall was a man of great energy and untiring industry, and only last year he journeyed as far as St. Petersburg to take part in the meeting of the International Geological Congress.

AN appeal which should be given the active and generous support of the scientific world has been made by Dr. F. T. Bond, of Gloucester, Secretary of the Jenner Society. The Vaccination Bill, which received the Royal Assent on Friday last, makes it incumbent upon those who believe in vaccination to establish an organisation which will systematically defend it against the assaults of anti-vaccinatists. "It was to carry on this work" (explains Dr. Bond) "that the Jenner Society was established more than two years ago, in the year of the Jenner centenary, both as a memorial of that great investigator and as a means of meeting the agitation against vaccination which the Anti-Vaccination League had for so many years been, without opposition, carrying on. During that time the Society has distributed a large amount of literature; it has procured the insertion in newspapers in all parts of the country of some hundreds of articles and letters in reply to the correspondents whom the Anti-Vaccination League maintains to disseminate its views; it has organised two important manifestoes on the subject of vaccination, one from the medical officers of health of the country, and the other from the county of Gloucester, and it has done its best to promote the emendation of the Vaccination Bill. Want of funds alone restricts its efforts. It has a large amount of instructive material ready for publication and circulation, which it cannot bring forward for want of means, and if it had not been for the liberality of the representatives of the medical profession it could not have carried on its work at all. If that work is to be maintained and extended, as it ought to be, the non-medical public must support it with at least as much liberality as the opponents of vaccination have hitherto subsidised the Anti-Vaccination League." It is to be hoped that this appeal will meet with every encouragement, so that the Society shall be able to make its operations felt over an extensive field.

THE fiftieth anniversary of the foundation of the American Association for the Advancement of Science will be held next week at Boston. The meeting promises to be a very successful one, and a large number of papers have been received for reading in the various sections. The general programme has already been described in NATURE (July 7), but a few new items may be referred to here. In the Section of Chemistry the papers will be taken in groups as follows:—Analytical Chemistry, led by Dr. P. De P. Ricketts, Columbia University; Teaching of Chemistry, Dr. F. P. Venable, University of North Carolina; Inorganic Chemistry, led by Dr. H. L. Wells, Yale University; Organic Chemistry, Dr. Ira Remsen, Johns Hopkins University; Physical Chemistry, Dr. T. W. Richards, Harvard University; Physiological Chemistry, led by Dr. E. E. Smith, New York; Agricultural Chemistry, led by Dr. H. A. Weber, Ohio University; Technical Chemistry, Dr. N. W. Lord, Ohio State University. The Section of Mathematics and Astronomy is to be favoured with the following reports on recent progress (accompanied with statements of some of the "standing problems"), prepared on the special invitation of the officers and committee, "with a view to obtaining at this anniversary meeting such a survey of the field as may lead to a possible co-operation of effort": Report on the recent progress in the dynamics of solids and fluids, by Dr. Ernest W. Brown; report on theory of invariants—the chief contributions of a decade, by Prof. Henry S. White; Report on the recent progress in the mathematical theory of electricity and magnetism, by Prof. Arthur G. Webster; Report on the modern group-theory, by Dr. G. A. Miller; meteorology from a mathematical and physical point of view, by Prof. Cleveland Abbe. There will be several joint meetings of sections for the discussion of subjects of mutual interest, and every effort is being made to make the meeting worthily commemorate the Association's jubilee, and at the same time advance the interests of science in the United States.

THE retirement of Prof. J. R. Eastman, of the United States Naval Observatory, is announced in *Science*. Prof. Eastman has been continuously connected with the observatory since 1862.

THE death is announced of M. J. M. Moniz, known by his investigations of the natural history of Madeira, where he died on July 11 at the age of sixty-six.

DR. WILLIAM PEPPER, of Philadelphia, the author of many works on medical and other scientific subjects, died a few days ago. Dr. Pepper was prominent in many of the public institutions in Philadelphia, and did much to assist scientific, educational and medical progress in that city.

WE regret to see the announcement of the death of Mr. J. A. R. Newlands, to whom belongs the credit of the discovery of the periodic relations between the atomic weights of the elements. In the year 1887 Mr. Newlands was awarded the Davy Medal of the Royal Society in recognition of his work.

THE death is announced, at Oran, of a distinguished French mining engineer. M. Pomel. He was professor of geology at the Algiers Scientific School, director of that school from 1883 to 1888, and ex-president of the French Geological Society. M. Pomel leaves a number of special works, among which may be mentioned "Le Sahara" and "La Carte Géologique de la Province d'Oran."

THE young male giraffe from Senegal, which was one of the latest additions to the menagerie in the Zoological Society's Gardens, has just died. This rare animal cost the large sum of 900*l*.

A REUTER telegram announces that the screw schooner *Godthaab* sailed from Copenhagen on Wednesday morning for Angmagsalik, in East Greenland, with an expedition under First Naval Lieutenant Amdrup. The expedition, which has been fitted out by a scientific institute at a cost of 150,000 kroner, is provisioned for two years. Its object is to explore the east coast of Greenland between the 66th and 70th degree north latitude, with Angmagsalik as its starting-point.

DURING the latter part of the last, and the beginning of the present week, some high shade temperatures have been recorded over the southern and central parts of England. The weather conditions have been generally anti-cyclonic, the barometer standing at about 30·5 inches over the eastern half of the Baltic, and exceeding 30 inches over the Continent and the south-east of England, with very little differences in the readings over considerable areas. On the 12th the shade temperatures at several stations varied from 80° to 85°, and these readings have been since reached or exceeded, 87° having been registered on several days in the neighbourhood of London, while in the sun's rays the thermometer has exceeded 140°. During the night of the 15th and 16th a sharp thunderstorm occurred over the south-eastern parts of England and in Yorkshire; but the rainfall reported to the Meteorological Office was nowhere heavy, the greatest amount (0·4 inch) being registered in Yorkshire.

A NEW genus, *Limnocarpus*, has been founded by Mr. Clement Reid for the fruit of an aquatic plant, which occurs throughout the Oligocene strata of the Hampshire Basin (*Journ. Linnean Soc.*, vol. xxxiii.). The type-specimens of this plant, which is allied to *Potamogeton* and *Ruppia*, were obtained from the Lower Headon beds of Hordle cliff.

THE address delivered by M. Grimaux at the recent meeting of the French Association for the Advancement of Science at Nantes is printed in full in the *Revue Scientifique* of August 6. The subject of the address was "La Chimie des infiniments petits"—the new chemistry which was founded by Pasteur, who demonstrated that a host of obscure reactions are due, directly or indirectly, to micro-organisms. M. Grimaux indicated some of the chief results obtained in this branch of scientific inquiry, and pointed out the main features of the work of Pasteur and of the host of disciples who are developing, extending, and completing the work of the master. The meeting at which M. Grimaux was to have delivered the address was unfortunately marred by the expression of hostile public feeling against the distinguished president of the Association, on account of the position he had taken in a case which has lately caused much commotion in France. At the opening ceremony of the Association, M. Grimaux was unable to deliver his address, so violent and noisy were the manifestations against him. Finally, the address was delivered before members of the Association in one of the local schools, to which the public were not admitted. It is deeply to be regretted that a man of scientific distinction and high reputation should have received such an unpleasant reception merely on account of his support of M. Zola in the protest against the sentence on ex-Captain Dreyfus. The words used by M. C. A. Laisant, the secretary of the Association, in concluding his report upon the work and progress of the year, should have been taken to heart by that section of the Nantes public which have brought discredit upon the city by the recent manifestations; they are:—"Soit dans l'étude de ces questions si importantes pour l'intérêt du pays tout entier, soit dans les excursions qui charmeront les uns par l'attrait de la nouveauté ou qui rappelleront à d'autres les souvenirs de leur jeunesse, soit enfin dans vos travaux de sections, consacrés à la science pure, vous vous sentirez de plus en plus attachés à notre chère Association, qui nous rapproche tous dans un culte commun de la vérité, et qui nous permet d'oublier en passant les divisions et les discordes, trop fréquentes, hélas! parmi les hommes, en dehors du monde de la science."

A NUMBER of members of the French Association were the recipients of honours during the year covered by the report presented by the Secretary to the recent meeting at Nantes. Among the nominations to professorships are:—M. Maquenne, as professor at the Muséum; MM. Moussous and Denigès, as professors at the Faculté de Bordeaux; MM. Bordier, Broca, Launois and Sambuc, as Fellows of the Faculty of Medicine; MM. Bourquelot, Perrier, Peyrot, Richer and Richet, as members of the Academy of Medicine; and M. Schlagdenhauffen, as associé libre. In the Order of the Légion d'honneur the dignity of Grand Officer was conferred upon MM. Dislère and Himly, de l'Institut; the grade of Commander upon Colonel Renard; the grade of Officer upon MM. Chavanon, Claude Lafontaine, Dubar, Faisans, H. Filhol, Ch. Gauthiot, Dr. Hayem, G. Payelle, Dr. Raymond, Georges Rolland, and Dr. Zaepffel. Among the Chevaliers the Secretary mentions MM. Arnavon, Dr. Barth, Blin, Arth, Boudin, Fernand Faure, A. Gatine, Jules Grouvelle, Dr. Heydenreich, Lebois, Macé de Lépinay, Dr. Alf. Marchand, E. A. Martel, A. Molteni, Pralon, Dr. Jean Rivière, A. Taillefer, Dr. J. Teissier, and Aug. Wallaert. Among the lauréats de l'Académie des sciences, the names are mentioned of Beauregard (prix Godard), Bourquelot (prix Montagne), André Blondel (prix Planté), Durante and Henri Meunier (prix Lallemand), Gaucher and Rémy (prix Montyon), Hébert (prix Cahours), P. Pruvot (prix Bordin), Paul Sabatier (prix Lacaze), Joseph Vallot (grand prix des sciences physiques), Gosselet (prix d'Ormoy). In the Academy of Medicine prizes have been awarded to MM. Censier, Denigès, Destot, Ducor, Grasset, Hallion, Lalesque. This list shows that the Association numbers many active investigators among its members.

THE publications of the Royal Alfred Observatory, Mauritius, have been distributed somewhat irregularly, and most European libraries have only incomplete sets. The announcement in *Symons's Monthly Meteorological Magazine*, that, for convenience of distribution, all surplus copies have been sent to Mr. G. J. Symons, F.R.S., ought, therefore, to be widely known. A list of the publications available is given in that magazine, and applications for any of them should be sent to Mr. Symons, 62 Camden Square, London, N.W., by October 15, when the remaining copies will be allotted.

THE University of Upsala continues to issue a well-printed and well-illustrated *Bulletin* of its Geological Institution. In part 2 of its third volume the *Bulletin* deals with a variety of topics relating to Swedish geology: with graptolites, corals, and mammals; with minerals and mineral veins, and with subjects of chemical and structural geology. A paper by

H. Munthe treats of the vexed question of the interglacial submergence of Great Britain; and being printed in English, it will more readily attract the attention of British geologists. The author first deals with the marine clay at Cleongart, on the western coast of the Mull of Kintyre; and he shows that the idea of the mixed character of the fauna, both as to climate and bathymetrical conditions, arose from considering the fauna generally, whereas in reality there is a distinct series of layers which were deposited under different conditions. He regards the strata as *in situ*, and as indicating a maximum submergence of over 300 feet. He gives reasons, also, for believing that the marine clay at Clava, near Inverness, is likewise a marine deposit *in situ*, and that it indicates a submergence of at least 540 feet. In other localities in Great Britain and Ireland he is disposed to think that certain shelly gravels may have been transported by an ice-sheet from lower to higher levels.

THE water question being temporarily in abeyance, the London County Council have employed the interval in issuing a report on the "Bacteriological examination of London crude sewage." It only purports to be an introduction to reports on experiments which are in progress on the filtration of sewage through coke, and contains nothing of significance from a scientific point of view. The flora of sewage has been repeatedly studied before, and that the *B. coli communis* is present in great numbers is hardly news to those acquainted with the subject; on the other hand, some of the statements made are liable to a highly misleading interpretation. We would especially refer to the remark that the presence of the *B. coli communis* in water may be regarded as a "bacteriological method of detecting the pollution of water with minimal quantities of sewage which is of very great delicacy." This organism is, like the poor, always with us, and that its presence is necessarily due to the access of sewage is a quite unwarranted assumption. Again, because a liquid contains bacteria capable of liquefying gelatine, does it follow that this liquid is "also rich in ability to dissolve solid or suspended organic matter"? To justify such statements more than words are necessary, and in a scientific report surely experiments should take precedence of conclusions. Experiments on coke filters in relation to sewage treatment are being vigorously prosecuted in various parts of the country, and the London County Council are showing their appreciation of the importance of the question in likewise directing investigations in this direction; and we trust that the united efforts of so many independent bodies will ultimately yield data which will materially lessen the stupendous difficulties now surrounding the satisfactory disposal of sewage.

THE Deutsche Seewarte has issued its twentieth yearly volume of *Aus dem Archiv*, for 1897. Among the various investigations, which are always of a painstaking and valuable character, we would refer to one by Dr. Neumayer and Dr. v. Hasenkamp, entitled "Anemometer Studies." The results confirm those obtained by Mr. Dines and others, with regard to the high values recorded by the Robinson cup-anemometer, and also show that anemometers of similar pattern and size cannot be depended upon to give precisely similar records, but that the constants of each individual instrument must be separately determined. Another important discussion, by Dr. G. Schott, refers to the "bottle-notices" collected by the Seewarte up to the end of the year 1896. The drift of 643 bottles has been examined, and with one or two exceptions the routes have been plotted on charts. Some of the tracks taken are very interesting, and go to disprove the statement sometimes made that the bottles are driven by the prevalent winds. Some instances are given showing that the bottles follow even a weak current, against the wind. About seventy per cent. of the notices refer to the North Atlantic ocean.

IN *Das Wetter* for July, Dr. R. Hennig, of Berlin, concludes an interesting investigation of the well-known "cold days" of May, which has appeared in the last four numbers of that journal. In carrying on the discussion the author has examined all the weather charts for the last twenty years, and has given a summary of the special conditions in each of those years. The principal results are arrived at are: (1) That the "cold days" are, with rare exceptions, a yearly recurring phenomenon, but by no means affect the same parts of Europe. (2) The period of the occurrence varies considerably. It may embrace the whole month, but most frequently takes place during the second decade, and mostly lasts for three or four days. (3) The phenomenon generally commences during the occurrence of stormy north-west winds, accompanied with frequent showers of rain, snow or hail. Night frosts and formation of hoar frost sometimes occur during the early period of this unsettled weather, but generally take place after the passage of areas of low barometric pressure. (4) During this cold period an extensive area of high barometric pressure obtains over the ocean adjacent to the western or north-western shores of Europe. This subject has engaged the attention of meteorologists for a number of years, and among the various investigations we would especially refer to those of Dove in 1856, and v. Bezold in 1882.

IN consequence of the great development which the study of earthquakes has received in Europe, and especially in Italy, during the last ten years, the need has been felt of a journal devoted exclusively to seismology. Accordingly, in the beginning of 1895, Prof. Tacchini, the well-known Director of the Central Office of Meteorology and Geodynamics at Rome, founded the Italian Seismological Society. Three volumes of the *Bollettino* published by the Society are now complete. Their value will be evident from the notes which we have inserted from time to time. Besides the important notices of earthquakes recorded in Italy, the three volumes contain altogether seventy-six papers, chiefly on earthquakes, though the active volcanoes of the country receive a large share of attention. Most of the papers are in Italian, but a few are written in French; and, as those in other languages are also admissible, it is evident that the *Bollettino* possesses an international character. The Society has at present fifty-three Italian and foreign members, and stands in need of a considerable increase in their number, in order that its usefulness may be maintained and extended.

THE Report of Mr. W. E. Hoyle, Keeper of the Manchester Museum, Owens College, shows that much useful work was accomplished during the year 1897-8 in spite of inadequate funds. Specimens of minerals and fossils which could be spared were arranged by Mr. H. Bolton in sets and presented to schools in which they will prove of service. Series of short addresses upon natural science topics were given on Saturday and Sunday afternoons, and were so successful that similar lectures will be delivered during the ensuing session. A museum which carries on work of this character, in addition to publishing useful handbooks—one on the nomenclature of the seams of the Lancashire Lower Coal Measures, by Mr. Herbert Bolton, is now before us—and furnishing material to aid naturalists in their investigations, ought to be given every encouragement. In regard to the acquisition of specimens, Mr. Hoyle points out that the sum of 75*l*. a year, which has for some time been allotted for this purpose, is absurdly inadequate for the principal museum of the city of Manchester, especially when compared with the sum of 2000*l*. expended in the same manner by the city of Liverpool. The Free Library Committee of the Manchester Corporation has shown its appreciation of the work of the Museum by contributing the sum of 400*l*. per annum towards its maintenance, but beyond this no assistance is received from

the Corporation. The sum expended on the Manchester Museum, including special donations, is only 2785*l.*, whilst the neighbouring city of Liverpool spends 5700*l.* Bearing this comparison in mind, the citizens of Manchester would do well to consider the following words of a recent American writer on the subject of museums referred to by Mr. Hoyle:—"It is not too much to assert that the level reached in intelligence and organisation by any community may be gauged most accurately by the attention and support afforded to its museums."

THE fifth edition of Mr. L. Cumming's "Electricity treated Experimentally" has just been published by Messrs. Longmans, Green, and Co. A few slight additions and alterations have been made to this useful little work, in order to bring it into touch with the present state of knowledge of the subjects surveyed in it.

THE May number of the *Journal of the Federated Institutes of Brewing* contains an interesting paper on the water supplies of Yorkshire, by Mr. Thomas Fairley. The great variety of waters existing in Yorkshire is remarkable, even when the size of the county is taken into consideration. Mr. Fairley classifies them in convenient tables, and makes useful comments on their origin and properties, both from the hygienic and technical point of view.

IN reference to recent discussions and decisions on the vaccination question, it will be of interest to note that Messrs. Macmillan and Co., Ltd., have now in the press, and will publish early in the autumn, the Milroy lectures on "Vaccination, with special reference to its natural history and pathology," by Dr. Monckton Copeman, Medical Inspector to the Local Government Board, whose name is so widely and favourably known in connection with the new glycerine treatment of vaccine, the use of which is prescribed in the Bill which has now been approved by both Houses of Parliament.

DR. W. GROSSE, of Bremen, has written a small book entitled "Der Aether und die Fernkraefte," compiled from various sources, as a short history of the more recent developments of the researches of Hertz and Roentgen. The remarkable stimulus to scientific investigators produced by the publication of Roentgen's great discovery is indicated by the fact that within a few months the *Beiblätter* was devoting no less than eighty pages per volume to X-rays. "Telegraphy without wires" is treated of by Dr. Grosse with a brave attempt to do equal justice to all who have, or think they have, priority.

"ASTRONOMY for the Young" (London: G. Stoneman, 1898) is the title of a small book of sixty-two pages by Mr. Thynne Lynn. The author describes in very popular and elementary language a few general notions about the earth, her satellite the moon, the sun, the planets, comets and meteors, and lastly the stars, giving the young reader a general notion, in a few words, of the bodies which we see in the heavens by day and night. The book is simply written, and few, if any, technical terms are used, so that it is well adapted to the readers for whom it is intended. Perhaps it might have been better to have omitted the illustration on p. 31, displaying the "phenomena of the heavens;" as a rainbow, halo, aurora, waterspout, a lightning flash, &c., are all jumbled up together, and are more inclined to puzzle than enlighten a young reader.

MR. A. H. EVANS's volume on "Birds," for the Cambridge Natural History, is now so well advanced that Messrs. Macmillan and Co. hope to publish it in the course of September. With few exceptions the illustrations have all been specially drawn for the book by Mr. Lodge, and engraved on wood by O. Lacour. The treatment of the subject throughout is systematic, and the author has taken special pains to describe each bird so minutely that a naturalist or sportsman in the field will have no difficulty in identifying any specimen. The next volume to appear will be the completion of Dr. Sharp's admirable treatise on insects. This may be looked for not later than January.

THE *Revue Scientifique* for July 30 contains a summary of M. Berthelot's recent researches on the relations existing between the energy of light and chemical energy. M. Berthelot's leading idea is that the true chemical equivalent of light energy can only be measured by means of an endothermic irreversible reaction—that is to say, by a reaction which progresses with absorption of energy, and with the formation of products which cannot re-combine spontaneously under the circumstances of the experiment. These conditions exclude many actinometric methods hitherto used. Thus a mixture of hydrogen and chlorine cannot be employed, for in this case the action induced by light is exothermic; the energy liberated is not that which has been received as light, but is almost wholly due to the chemical energy pre-existing in the uncombined hydrogen and chlorine. Photographic actinometers are also excluded for the same kind of reason, as well as from the fact that in some cases the products of the reaction tend to re-combine. Thus metallic silver or silver subchloride and free chlorine produced by the action of light on silver chloride can re-combine spontaneously. The reactions studied by M. Berthelot are the decomposition of nitric acid into nitrogen peroxide, oxygen and water, and the decomposition of iodic acid, hydriodic acid, and oxide of mercury respectively into their elements. It was observed incidentally that the more refrangible rays only are effective in the cases of nitric and hydriodic acid, and that in the decomposition of hydriodic acid a periodide of hydrogen is formed intermediately. Carbon dioxide, and a mixture of carbon monoxide and oxygen were not affected by exposure to sunlight. M. Berthelot is engaged in a deeper study of the energy relationships.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*, ♀) from India, presented by Mr. H. Page; a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. C. E. Bashall; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. M. Titford; a Smooth-bellied Snake (*Homalosoma lutrix*), a Rufescent Snake (*Leptodira hotambaia*), two Rhomb-marked Snakes (*Trimerorhinus rhombeatus*), five Crossed Snakes (*Psammophis crucifer*), three Puff Adders (*Bitis arietans*) from South Africa, presented by Mr. J. E. Matcham; two Pinche Monkeys (*Midas œdipus*) from Columbia; a Grey Parrot (*Psittacus erithacus*) from West Africa, deposited; two Three-toed Sloths (*Bradypus tridactylus*) from British Guiana, purchased; an Humboldt's Lagothrix (*Lagothrix humboldti*) from the Upper Amazons, a Red-backed Saki (*Pithecia chiropotes*) from Guiana, received in exchange.

## OUR ASTRONOMICAL COLUMN.

WOLF'S COMET.—The following is a continued ephemeris for this comet, the positions being stated for Berlin midnight:—

| | R.A. h. m. s. | Decl. ° ′ | Br. |
|---|---|---|---|
| August 18 | 5 13 12 | +15 20 | 2·49 |
| 22 | 22 52 | 14 29 | 2·50 |
| 26 | 32 13 | 13 36 | 2·53 |
| 30 | 5 41 13 | +12 39 | 2·55 |

On June 18, Prof. Hussey, who rediscovered the comet on the previous day with the Lick 36-inch refractor, found the comet an easy object with the 12-inch telescope (*Ast. Jour.*, 439).

FALL OF A METEORITE IN BOSNIA.—A correspondent has sent us the following extract from the *Foreign Office Annual*, 1898 (No. 2167, "Trade of Bosnia and the Herzegovina for the

year 1897," p. 7):—It may be interesting to mention that shortly before noon on August 1 last year a large meteorite fell at Zavid near Rožanj, in the district of Zvornik. Unfortunately, as soon as it cooled, peasants of the neighbourhood knocked off pieces of it, but about 80 per cent. of the mass remained. It buried itself a yard deep in the ground, with the so-called breast uppermost. Eye-witnesses of its fall say that it was accompanied by a noise like thunder, lasting several minutes and audible a long way off. It left a fiery streak behind, which a short way above the horizon divided in two, and above this streak or tail was a thick cloud of smoke. This meteorite is now in the museum of this town, and measures 55 by 35 by 28 centims. It was broken by the fall in several pieces, but has been joined together again. This is the first aerolite which has been found in Bosnia.

THE NEW OBSERVATORY AT HEIDELBERG.—The opening of the new observatory at Heidelberg, on June 20, is an event of no little importance, more especially as the instrumental equipment is designed for the pursuit of both of the great branches of astronomy. The astrometric department is in the capable hands of Prof. Valentin, who, in addition to more purely scientific problems, is charged with the determination of time and its communication to the railways and various other establishments. The most important instrument is a meridian circle by Repsold, of 6 inches aperture.

Prof. Max Wolf, who has achieved such brilliant success in celestial photography, is in charge of the astrophysical work of the observatory, and we are glad to know that the buildings have been specially arranged to facilitate the continuation of his researches. The equatorial, which has served Prof. Wolf so well, is placed under a dome of nearly 18 feet diameter, the construction of which is so perfect that it can be turned completely round in 8 seconds. Another dome of nearly 20 feet diameter will shelter the astrophotographic instrument, which the observatory will owe to the generosity of Miss Bruce. The lenses for this instrument are being made by Brashear.

AN ASTRONOMER'S REMINISCENCES.—In the first of a series of "Reminiscences of an Astronomer," which Prof. Simon Newcomb contributes to the August number of the *Atlantic Monthly*, several incidents and opinions of interest to astronomers are related. Referring to Cayley, Prof. Newcomb says: "His life was that of a man moved to investigation by an uncontrollable impulse; the only sort of man whose work is destined to be imperishable." After a short description of the work of Leverrier and Adams, which led to the discovery of Neptune, we read: "Adams's intellect was one of the keenest I ever knew. The most difficult problems of mathematical astronomy and the most recondite principles that underlie the theory of the celestial motions were to him but child's play." Airy is regarded as "the most commanding figure in the astronomy of our time. He owes this position not only to his early works in mathematical astronomy, but also to his ability as an organiser." Experience in the United States led Prof. Newcomb to anticipate a difficulty in getting the various telegraph stations between Gibraltar and Greenwich connected for longitude operations, and in discussing the work he asked Airy how the connections could be made from one end of the line to the other, at the same moment. "Nothing is simpler," replied Airy. "I set a moment, say eight o'clock Greenwich mean time, at which signals are to commence. Every intermediate office through which the signals are to pass is instructed to have its wires connected in both directions exactly at the given hour, and to leave them so connected for ten minutes, without asking any further instructions. At the end of the line the instruments must be prepared at the appointed hour to receive the signals. All I have to do here is to place my clock in the circuit and send on the signals for ten minutes commencing at eight o'clock. They are recorded at the other end of the line, without further trouble." This incident is a good lesson in astronomical method.

## *THE FORTHCOMING INTERNATIONAL CONGRESS OF ZOOLOGY.*

THE following is the programme of the fourth International Congress of Zoology, which begins at Cambridge on Monday next, under the patronage of H.R.H. the Prince of Wales, and the presidency of the Right Hon. Sir John Lubbock, Bart., M.P., F.R.S.:—

The Reception Room (Masonic Hall, Corn Exchange Street) will be open from 9 a.m. to 7 p.m. on Monday, August 22, and on the four following days; and from 9 a.m. to 1 p.m. on Saturday, August 27.

Monday, August 22, 9 p.m. to 11 p.m.—Reception at the Guildhall by the Mayor of Cambridge. Members of the University and of the Town Council are requested to wear gowns; Doctors and Aldermen, scarlet.

### *Proceedings of the Congress.*

Tuesday, August 23, 10.30 a.m., at the Guildhall.—Opening of the Congress by the President. Election of officers. Receipt of reports of Committees appointed by the third Congress, and other business. 2 p.m.: Meetings of the Sections.

*Note.*—The Sections will be: (*a*) General Zoology, at the Guildhall (No. 1 on the plan of the museums on the members' tickets); (*b*) Vertebrata, in the Lecture Room of the Cavendish Laboratory (No. 2 on the plan); (*c*) Invertebrata (except the Arthropoda), in the Lecture Room of the Chemical Laboratory (No. 4 on the plan); (*d*) Arthropoda, in the Lecture Room of Comparative Anatomy (No. 6 on the plan). 5.50 p.m.: Organ recital in King's College Chapel. 9 p.m. to 11 p.m.: Reception by the Vice-Chancellor at Downing College.

Wednesday, August 24, 10.30 a.m., at the Guildhall.—General meeting of the Congress to discuss the position of sponges in the animal kingdom. The discussion will be opened by Prof. Yves Delage, of Paris, and Mr. Minchin, of Oxford.

*Note.*—There may also be meetings of the Sections. 2 p.m.: Meetings of the Sections. 9 p.m.: Conversazione in the Fitzwilliam Museum in conjunction with the International Congress of Physiologists.

Thursday August 25, 10.30 a.m., at the Guildhall.—General meeting of the Congress to discuss the origin of Mammals. The discussion will be opened by Prof. Seeley, of London, and Prof. H. F. Osborn, of New York.

*Note.*—There may also be meetings of the Sections. 2.15 p.m., at the Senate House: The conferring of honorary degrees. 4–6.30 p.m.: Garden party in the Botanic Garden of the University.

Friday, August 26, 13.30 a.m., at the Guildhall.—General meeting of the Congress to hear an address by Prof. Haeckel, "On our present knowledge of the Descent of Man." The Right Hon. Sir Herbert Maxwell, Bart., M.P., will afterwards read a paper "On recent Legislation on the Protection of Wild Birds in Britain."

*Note.*—There may also be meetings of the Sections. 2 p.m.: Meetings of the Sections. 7.30 p.m.: Dinner in the hall of Trinity College. Tickets, price 15*s*., must be applied for in the Reception Room not later than 1 p.m. on Wednesday, August 24.

Saturday, August 27, 9.30 a.m., at the Guildhall.—General meeting of the Congress to settle the time and place of the Fifth International Congress.

### *Arrangements for the Congress in London.*

Saturday, August 27, 4 p.m. to 7 p.m.—Reception by the President and Council of the Zoological Society of London in their gardens in the Regent's Park, London. Tea and light refreshments will be served. 9 to 11.30 p.m.: Reception by the Right Hon. Sir John Lubbock, President of the Congress, of the members of the Congress, at the Natural History Museum, Cromwell Road.

Sunday, August 28, 2.30 p.m. to 7 p.m.: The Natural History Museum, Cromwell Road, will be open. Tea and light refreshments will be served to members of the Congress from 4 p.m. to 6 p.m. 9 p.m.: The President and Committee of the Royal Societies' Club, St. James's Street, S.W., will hold a reception in honour of the Congress (gentlemen only).

Monday, August 29.—Visit to Tring Museum. Visitors will be received by the Hon. Walter Rothschild, who will entertain them at lunch.

*Note.*—Notice of intention to visit Tring must be given in writing to the Secretaries not later than noon on Wednesday, August 24.

Tuesday, August 30.—His Grace the Duke of Bedford will be glad if such zoologists as are interested in the study of the Cervidæ will visit his parks at Woburn on Tuesday, August 30. Mr. R. Lydekker, F.R.S., has promised to conduct the party, which should not exceed in number sixty. Further information

may be obtained by applying to Mr. Lydekker, at The Lodge, Harpenden, Herts.

Monday and Tuesday, August 29 and 30.—The museum of the Royal College of Surgeons will be open to members of the Congress on production of their ticket. An official of the museum will be present to receive visitors.

Tuesday, Wednesday and Thursday, August 30 and 31, and September 1.—Dredging expeditions at Plymouth with the Director of the Marine Biological Laboratory, and at Port Erin, Isle of Man, under the direction of Prof. Herdman, F.R.S.

*Note.*—Visitors to either of these dredging expeditions should give notice to the Secretaries in writing as early as possible.

The gardens of the Zoological Society of London will be open to members of the Congress on showing their tickets and writing their names in the book at the gates every day, including Sunday, from Thursday, August 18, to Thursday, September 1, inclusive.

The Committee of the Royal Societies' Club, St. James's Street, S.W., will extend the privileges of honorary membership to members of the Congress (not ladies) on presentation of their cards of Congress membership, from August 18 to September 1, inclusive. Members of the Congress making use of the Club must enter their names in the visitors' book.

The President and Council of the Linnean Society, Burlington House, Piccadilly, will throw open their apartments to the members of the Congress of Zoology from August 27 to September 1, inclusive.

The gardens of the Royal Zoological Society of Ireland will be open to members of the Congress who visit Dublin on presenting their cards of membership at the gate.

## *A YORKSHIRE MOOR.*[1]

### I.

THE Yorkshire moor is high, ill-drained, peaty, and overgrown with heather. Moors of this type abound in Scotland, and creep southward along the hills into Yorkshire and Derbyshire, breaking up into smaller patches as the elevation declines. In the south of England they become rarer, though famous examples occur in Dartmoor and Exmoor. In the north they may cover great stretches of country. It used to be said that a man might walk from Ilkley to Glasgow without ever leaving the heather. That was never quite true, but even to-day it is not far from the truth; a man might walk nearly all the way on unenclosed ground, mostly moorland.

Neither peat nor heather is confined to high ground. Peat often forms at sea-level, and may contain the remains of sea-weed. In some places it is actually submerged by change of sea-level, and the peasants go at low water and dig through the sand to get it. Heather ranges from sea-level to Alpine heights.

Peat may form because there is no fall to carry off the water, or because the soil, though high and sloping, is impermeable to water. A few feet of stiff boulder-clay constitute such an impermeable floor, and a great part of our Yorkshire moors rests upon boulder-clay, which is attributed to ice-action, because it is often packed with ice-scratched pebbles, some of which have travelled far, and because the rock beneath, when bared, exhibits similar scratches.

The rocks beneath the boulder-clay of a Yorkshire moor are chiefly sandstones and shales. Where the sandstones crop out, they form tolerably bold escarpments with many fallen blocks, such as we call "edges" in the north; the shales make gentler slopes. Both the surface-water and the spring-water of the moors are pure and soft; they may be tinged with peat, but they contain hardly any lime, potash, or other mineral substance except iron-oxides.

The wettest parts of the moor are called *mosses* (in some parts of Scotland they are called *flow-mosses*) because the Sphagnum-moss grows there in profusion. The Sphagnum-swamps are an important feature of the moor, if only because they form a great part of the peat. Not all the peat, however; some is entirely composed of heather and heath-like plants, while now and then the hair-moss (Polytrichum) and certain moorland lichens contribute their share, but the Sphagnum-swamps play the leading part, especially in starting new growths of peat. If we walk carelessly over the moor, we now and then step upon a bed of Sphagnum. We have hardly time to notice its pale green tint and the rosy colour of the new growths before all close observation is arrested by the cold trickle of water into the boots. The practised rambler takes care to keep out of the Sphagnum swamps altogether, knowing that he may easily sink to the knees or further. Sphagnum sucks up water like a sponge, and if you gather a handful, you will be surprised to see how much water can be squeezed out of it. This water abounds in microscopic life; Amœbæ and other Rhizopods, Diatoms, Infusoria, Nematoids, Rotifers and the like can be obtained in abundance by squeezing a little Sphagnum fresh from the moors.[1] As the stems of Sphagnum grow upwards, they die at the base, and form a brown mass, which at length turns black, and in which the microscope reveals characteristic structural details, years, perhaps centuries after the tissues ceased to live.

An old Sphagnum moss is sometimes a vast spongy accumulation of peat and water, rising higher in the centre than on the sides, and covered over by a thin living crust. The interior

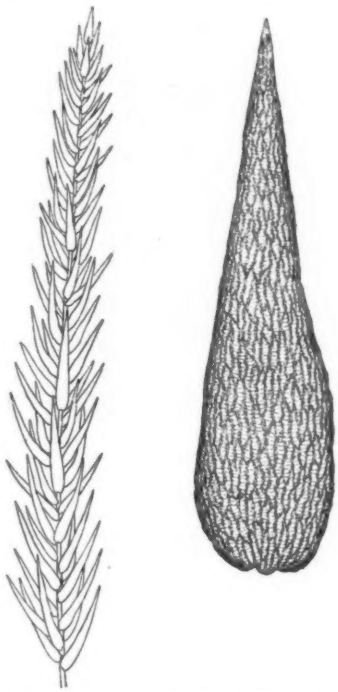


FIG. 1.—Leafy branch of Sphagnum, magnified; one leaf of ditto, further magnified.

may be half-liquid, and when the crust bursts after heavy rain, the contents of a hillside-swamp now and then pours forth in an inky flood, deluging whole parishes. In 1697 a bog of 40 acres burst at Charleville, near Limerick. In 1745 a bog burst in Lancashire, and speedily covered a space a mile long and half a mile broad. A bog at Crowhill on the moors near Keighley burst in 1824, and coloured the river with a peaty stain as far as to the Humber. In December 1896, a bog of 200 acres burst at Rathmore near Killarney, and the effects were seen ten miles off. Nine persons perished in one cottage.

The soaking-up of water is essential to the growth of the Sphagnum, which employs several different expedients for this purpose. Its slender stems give off numerous leafy branches, and also branches which are reduced to filaments. These last turn downwards along the stem, which they may almost conceal

[1] A discourse given at the Royal Institution, February 1898. By L. C. Miall, F.R.S.

[1] It is interesting to note that the same abundance of animal life characterises the mosses of Spitzbergen, where not a few of the very same species are found. (D. J. Scourfield, "Non-marine Fauna of Spitzbergen," *Proc. Zool. Soc.*, 1897.)

from view. The crowded leaves have in-folded edges. There are thus formed innumerable narrow chinks, in which water may creep upwards. The microscope brings to light further contrivances, which answer the same purpose. Many of the cells of the leaf lose their living substance, and are transformed into water-holding cavities with thin, transparent walls, which are prevented from collapsing by spirally wound threads. But the water must not only be lodged; it must ascend, and supply the growing branches above. Accordingly the water-holding cells are not closed, but pierced by many circular pores, which allow liquid to pass in and out freely. Perforated water-cells also form the outer layers of the stem. Thus the whole surface of the plant, whether immersed or not, is overspread by a water-film, which is easily replenished from below as it evaporates above. It is the water-spaces which render the Sphagnum so pale. The green living substance forms only a thin network, traversing the water-holding tissue.

Now and then we are lucky enough to see the bed of a Sphagnum-swamp. Quarrying, or a land-slip, or the formation of a new water-course, may expose a clean section. I have known the mere removal of big stones, time after time, from the bed of a

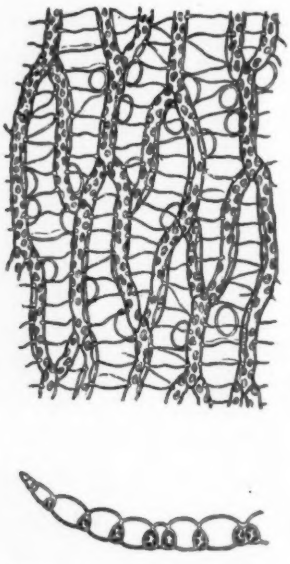


FIG. 2.—Detail of Sphagnum-leaf; green cells with corpuscles, and water-cells with spiral threads and pores. Below is a section (from Sachs) of part of a leaf.

stream fed by a Sphagnum-swamp, gradually increase the cutting-power of the running water, until the swamp is not only drained, but cut clean through down to the solid rock. Then we may see that the peat rests upon a sheet of boulder-clay, and this upon the sandstones and shales. Between the peat and the boulder-clay there is sometimes found an ancient seat-earth, in which are embedded the mouldering stumps of long-dead trees. Oak, Scotch fir, birch, larch, hazel, alder, willow, yew and mountain-ash have been met with.[1] Where a great tract of peaty moorland slowly wastes away, the tree-stumps may be found scattered thick over the whole surface. Above the seat-earth and its stumps, if these occur at all, comes the peat, say from 5 to 20 feet deep, and above the peat the thin crust of living heather.

Every part of the moor has not, however, the same kind of floor. Streams in flood may excavate deep channels, and wash out the gravel and sand into deltas, which often occupy many acres, or even several square miles. The outcrops of the sandstones crumble into masses of fallen blocks. Instead of the usual impervious bed of boulder-clay, we may get a light sub-soil. The verges of the moor have commonly this character; they are by comparison dry, well drained, and overgrown with furze, bilberry, crowberry, fern, and wiry grasses; such tracts are called "roughs" or "rakes" in the north of England. A similar vegetation may be found far within the moor, though not in places exposed to the full force of the wind. Even on the verges of the moor there are very few earthworms, and at most a scanty covering of fine mould; in the heart of the moor there is no trace of either. The Nematoid worms which are so common in most soils, and easily brought to the surface by pouring a few drops of milk upon the ground, seem to be absent from the moor. Insects and insect-larvæ are very seldom found in the humus.

In a country where population and industry grow steadily, it is rare to find the moor gaining upon the grass and woodland. We have to go back some centuries to find an example on anything like a large scale. The Earl of Cromarty (*Phil. Trans.* No. 330, p. 296), writing in 1710, says that in 1651 he saw a "firm standing wood" of dead fir-trees on a hill-side in West Ross-shire. About fifteen years later he passed the same spot, and found no trees, but a "plain green moss" in their place. He was told that the trees had been overturned by the wind, and afterwards covered by the moss, and further that none could pass over it because it would not support a man's weight. The Earl "must needs try it," and fell in up to the arm-pits.

A section through a thick bed of peat will sometimes reveal the manner of its growth. The lower part is often compact, the upper layers of looser texture. It is not uncommon to find by microscopic examination that while the lower part is made up entirely of Sphagnum, the more recent growth is due to heather, crowberry, grasses, hair-moss, and lichens. In some places the whole thickness is of Sphagnum only; in others there is no Sphagnum at all. Peat formed of Sphagnum only has no firm crust, and from the circumstances of its growth it is likely to be particularly wet. Sphagnum often spreads over the surface of pools or even small lakes, not nearly so often in Yorkshire, however, as in a country of well-glaciated crystalline rocks, where lakes abound. In such cases a peculiar kind of peat is formed as a sediment at the bottom of the water, which may in the end fill up the hollow altogether. A very slight cause is enough to start a Sphagnum bog, such as a tree falling across a stream, or a beaver-dam. When a pool forms above the dam, the Sphagnum spreads into it, and the peat begins to grow. Long afterwards, when the hollow is completely filled with peat, there may be a chance for grasses, rushes, crowberry and heather.

In our own time and country the moors waste faster than they form; it is much commoner to find the grass gaining on the heather than to find the heather gaining on the grass. There is no feature of the Yorkshire hills more desolate than ground covered with wasting peat. The surface is cut up by innumerable channels, with peaty mounds between. These are either absolutely bare, or thinly covered with brown grasses and sedges. The dark pools which lie here and there on the flats are overhung by wasting edges of black peat. It is cheerful to step from this dismal territory to ground clothed with close-growing grasses of a lively green, such as we find where the peat has disappeared altogether.

The moors are commonly wet, very wet in places. In certain parts and during certain seasons of the year they are, however, particularly dry, and subject to a severity of drought which the lower slopes and the floor of the valley know nothing of. At lower levels trees give shelter from sun and wind; night-mists check evaporation, and even return a little moisture to the earth; the deep, finely divided soil lodges water, which is given off little by little, and in our climate never fails to yield an effective supply to the roots; pools and streams dole out sparingly the water which fell long before as rain. But the moor lies fully open to sun and wind. In March it is exposed to the east wind; in June to hot sun and cold, clear nights; in August there is perhaps a long spell of drought; in November heavy gales with abundance of rain. The summer is late; the moorland grasses make little growth before the beginning of June; even then the heather bears few young leaves, while the fronds of the bracken are only beginning to push through the soil. Whatever the weather, there is no protection against its extremes; there is no shelter and no shade. The air is cold; wind and the diminished pressure due to height favour rapid evaporation. Though the Sphagnum-patches form permanent bogs, a great part of the moor becomes far drier in a hot summer

[1] In Yorkshire I think that birch and alder are the commonest of the buried trees.

than any pasture or meadow. The top of the peat crumbles, and is blown about as dust, the loose sand can hold no moisture, bared surfaces of clay become hard as iron. Another feature which must profoundly affect the vegetation of the moor is the poverty of its water in dissolved salts. It is pure and soft, like distilled water, and contains hardly any mineral food for plants. The plants of the moor are subject to the extremes of wet and dry, to cold and to famine.

The best-known and most characteristic of the moorland plants are the heaths. Ling, the common heather, is the most

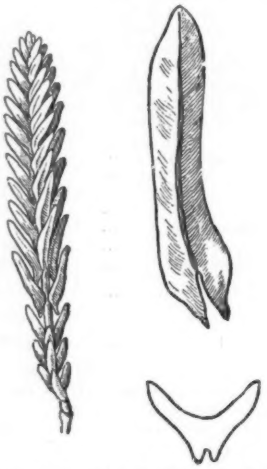


FIG. 3.—Ling (*Calluna vulgaris*). A leafy branch, a single leaf, seen from beneath, and a cross-section of the base of the leaf.

abundant of all; it sometimes covers many square miles together to the almost complete exclusion of other plants. Ling is a low shrub, whose wiry stems creep and writhe on the surface of the ground. When sunk in deep peat the stems are often pretty straight, but among rocks you may follow the twisted branches for many yards, and at last discover that what you took for small plants rooted near the surface are really the tops of slender trees, whose roots lie far below. Bilberry too wriggles among

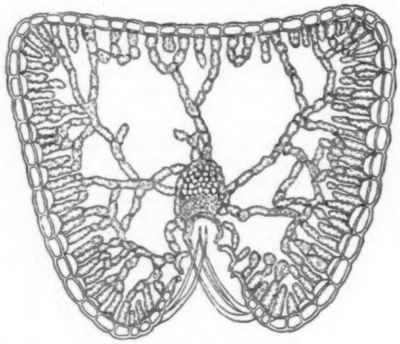


FIG. 4.—Transverse section of leaf of Ling, showing large air-spaces, the reduced lower epidermis which bears the stomates, and the long hairs which help to close the cavity into which the stomates open.

loose stones or fallen blocks till you grow weary of following it. The leaves of ling are dry, hard and evergreen. They last for two or three years, and do not fall off as soon as they die, but crumble slowly away. They are very small, densely crowded, and ranged on the branch in four regular rows. A good thin section through a leaf is not easy to cut; when you get one, you find that the interior is largely occupied by irregular air-spaces, and that the stomates are sunk in a deep groove on the under side of the leaf, where they are further sheltered by hairs.

Ling is a plant of slow growth, and a stem which showed seventeen annual rings was only a centimetre in diameter. Stems of greater age than this are rare. After ten or twelve years the plants flower scantily, and exhibit other signs of age. Then the common practice is to burn them off.

As we travel south, we find the ling getting smaller and smaller. In Scotland it is often waist-deep, in Yorkshire knee-deep, on Dartmoor only ankle-deep. On the moors of the south of England the ling is generally much mixed up with grasses, as

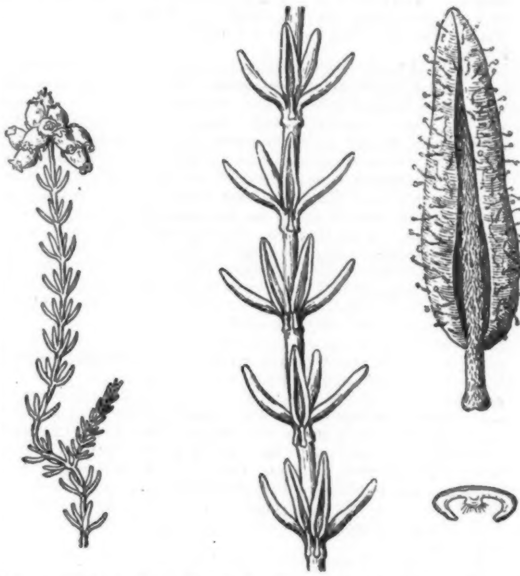


FIG. 5.—Cross-leaved Heath (*Erica tetralix*), with part of a branch, enlarged; a leaf seen from the under side, and a section of a leaf.

also on the verges of the Yorkshire moors. In Cornwall it may grow so close to sea-level that it is wet with salt spray in every storm, and its tufts are intermingled with sea-pink and sea-plantain. At the Lizard, wherever the serpentine comes to the surface, ling ceases, and the Cornish heath (*Erica vagans*) takes its place.

Here and there we find among the ling the large-flowered heaths with nodding pink or purple bells (Scotch Heath, Cross-leaved Heath). The leaves of these plants are much larger and

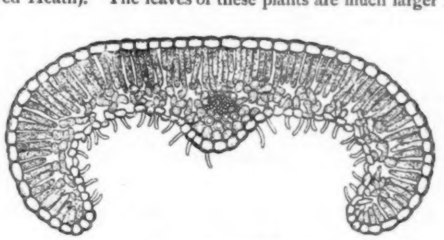


FIG. 6.—Transverse section of rolled leaf of cross-leaved Heath (*Erica tetralix*).

thinner than those of ling; they are called "rolled leaves," because the edges curve downwards and inwards, partly concealing the under surface, which bears the stomates. All our native heaths agree in possessing wiry stems, long roots, and narrow, evergreen leaves, with a glossy cuticle and small transpiring surfaces. The tissues are very dry, and burn readily even when green or drenched with rain. It is possible by good management to set acres of heather in a blaze, even in mid-winter, with a single lucifer match. The heaths wither very slowly when gathered, and change little in withering.

Some of these features are characteristic of desert-plants. Many desert-plants have reduced transpiring surfaces and hidden stomates. They often have very long roots, as was particularly observed in the excavations for the Suez canal.[1] The leaves are often small and crowded, the stems woody, much branched and tufted. Bright sunlight retards growth, and green tissues hardly ever present a large absorbing surface when they are habitually exposed to bright light. Accordingly the young shoots and branches do not push out freely, but try to hide one behind another. The tissues of desert-plants may be remarkably dry; they are often, however, remarkably succulent; the plant either learns to do without water for a long time together, or to store it up.

It is not without surprise that we learn how similar are the effects of tropical drought and of Arctic cold. The facts of distribution would in themselves suffice to show that our moorland heaths are well-fitted to endure great cold. Ling extends far within the Arctic circle, though it seldom covers large surfaces there, and it rises to 2000 metres (6600 feet) on the north side of the Alps It extends southward to the shores of the Mediterranean. Our large-flowered heaths have not been traced quite so far north as ling, and they are not found on the Alps, though they inhabit the Pyrenees. Many representatives of the heath family, with like structure of leaves, are found in the extreme north of the American continent. Those features which assimilate our heaths to desert-plants, and which seem to be obvious adaptations to a situation of extreme drought, are equally serviceable to plants which have to face boisterous winds and low temperature. The shrubs of the far north are low, tufted, small-leaved, evergreen, and dry—just like the heaths of our moors. Middendorff[2] shows how the Dahurian larch becomes stunted in proportion to increasing cold. Before it disappears altogether, it is cut down to a prostrate, creeping shrub. One such dwarf larch, though 150 years old, was only a foot or two across. Plants much exposed to biting winds must make the most of any shelter that can be had; their branches push out timidly, and for a very short distance; the leaf-surface is reduced to a minimum; since the warm season is short, evergreen leaves are profitable, for they enable the plants to take advantage of early and late sunshine.

The heaths and many other moorland plants bear the marks of the *Xerophytes*, or drought-plants. Xerophytes grow under a considerable variety of conditions, some of which do not suggest drought at first sight, but their tissues are always ill-supplied with water. It may be that water is not to be had at all, as in the desert; or that water must not be imbibed in any quantity because of low temperature, as in Arctic and Alpine climates; or that the water is mixed with useless and perhaps injurious salts, from which it can only be separated with great difficulty, as in a salt-marsh. Whatever may be the reason for abstinence, xerophytes absorb water slowly, part with it slowly, and endure drought well.

In the case of moorland plants there is an obvious reason why many of them, though not quite all (Sphagnum is one exception) should rather thirst and grow slowly than pass large quantities of water through their tissues. The water contains hardly any potash or lime, and very little that can aid the growth of a plant. But it is probable that this is not the sole reason. Except where special defences are provided, it is dangerous for a plant which may be exposed to wind or low temperature to absorb much water.

(*To be continued.*)

## INDIAN COALS AT THE IMPERIAL INSTITUTE.

THE Imperial Institute has been subjected to much adverse criticism. Its commercial collections, refreshment catering, fellows' club, limelight lectures by eminent men, continental orchestras, library, exhibitions, journal, and commercial intelligence department have all in turn been disparaged. The scientific and technical department has alone escaped attack. There, in well-equipped laboratories, with an enthusiastic staff of experts, valuable research work on new products has been carried on quietly and continuously for some years past. A striking example of the value of the work done is afforded by the exhaustive report just published on the coal supply of India by Prof. Wyndham R. Dunstan. This report embodies the results of the examination of a large number of selected samples from the principal seams. Methodically arranged, well printed, and written in a style that is not too abstruse for the general reader, it is a model of what such a report should be.

The examination was undertaken at the instance of the Government of India. The results are shown in a tabular form, and the chief points in connection with the occurrence, distribution, production and character of Indian coal are summarised. Unlike the English and Welsh coals, the Indian coals are chiefly of Upper Palæozoic and Lower Jurassic age. They are widely distributed, and only a small portion of the known coal area is as yet worked. The increase in coal production in India of late years is very remarkable, and, as the household consumption is inappreciable, practically the whole output is used for steamships, railways, and factories. The output for 1896 was as follows:—

| | Tons. |
|---|---|
| Assam ... ... ... ... | 177,351 |
| Baluchistan... ... ... ... | 10,572 |
| Bengal ... ... ... ... | 3,037,920 |
| Burma ... ... ... ... | 22,993 |
| Central India ... ... ... | 115,386 |
| Central Provinces... ... ... | 141,185 |
| Nizam's dominions ... ... | 262,681 |
| Madras } Punjab } ... ... ... ... | 79,925 |
| Total ... ... ... | 3,848,013 |

The results of the examination of the various coals have been plotted in curves, and a table of previous analyses of Indian coal is also given. The coals vary greatly in composition and in quality. Most of them are quite suitable for ordinary purposes, whilst some of the samples from Bengal and Central India are of excellent quality, quite equal to that of many English or Welsh coals. Among the many samples described are two from Hyderabad, which are of fair quality. Neither of the samples, however, gave such good results as those recorded by Mr. Tookey in Mr. J. P. Kirkup's monograph on the Singareni coalfield, published in the *Transactions* of the Federated Institution of Mining Engineers in 1894 (vol. vi. pp. 421-448). This valuable memoir appears to have escaped Prof. Dunstan's notice in drawing up his useful list of works of importance in connection with Indian coal. The Bengal coal is that most largely mined, and a great deal of it is a serviceable steam-coal. Many samples cake well, and contain but little sulphur. The coke made from this coal appears, therefore, to be suitable for iron-making. In view of the occurrence of rich deposits of iron and manganese ores in India, this is a matter of great importance, for, owing to difficulties connected with fuel supply, the records of iron manufacture in India have been disastrous. Attempts to manufacture steel in Southern India were made in 1818, in 1830, in 1833 and in 1853, but in each case the want of suitable fuel was an unsurmountable difficulty. Charcoal was exclusively used; and in order to supply one blast-furnace it was necessary to clear no less than two acres of moderately heavy forest per day. For every ton of charcoal made, five tons of wood were consumed. The information contained in Prof. Dunstan's report should therefore show that the difficulties in the way of creating an Indian iron industry presented by the fuel supply can easily be overcome. Indeed, the supply of coal is so enormous that this report should be the means of directing attention to the possibilities of many other branches of industrial enterprise.

BENNETT H. BROUGH.

## THE INTERNATIONAL AERONAUTICAL CONFERENCE.[1]

THE second meeting of the International Aeronautical Committee (which was appointed by the Paris Meteorological Conference of 1896) was held at Strassburg, Germany, March 31 to April 4, inclusive. Besides the President, Prof. Hergesell of Strassburg, and the Secretary, M. de Fonvielle of Paris, there were present the following members of the committee: Messrs. Cailletet and Besançon of Paris, Assmann and Berson of Berlin, Erk of Munich, Rykatcheff and Kowanko of

[1] Examples are quoted by Warming, *Lehrb. d. ökol. Pflanzengeographie*, p. 198.
[2] "Sibirische Reise," vol. iv. p. 605.

[1] By A. Lawrence Rotch. (Reprinted from the U.S. *Monthly Weather Review* for April.)

St. Petersburg, and Rotch of Boston, U.S A. Regrets were sent to Messrs. Hermite and Violle, whom illness detained, and thanks were tendered to those governments and friends of science who proposed to search for André, a member of the committee. A number of physicists, meteorologists, and aeronauts were present as guests. The welcome of the German Government was extended by Von Schraut, Minister of Finance for Alsace-Loraine, who summarised the results achieved in exploring the atmosphere, and predicted a brilliant future. Prof. Windelband, Rector of the University of Strassburg, emphasised the importance of these researches for the progress of humanity as well as for science. M. de Fonvielle replied for the Committee.

The discussion of the provisional programme was then begun, with the questions relating to the *ballons sondes*. It was agreed that the introduction of a mechanical ballast discharger was necessary, and that all precautions should be taken to prevent derangement of the instruments; the stoppage of the clockwork was attributed to the contraction of the plates carrying the pivots, from the effect of great cold. As regards the calculation of the ascensional force of balloons and the influence of the temperature of the gas, it was resolved that—

> For each unmanned ascent the weight of the aerostatic material and the ascensional force at the start should be measured, and during the whole voyage the true temperature of the gas should be recorded.

Since the study of the meteorological conditions of the air in a vertical line is important it was considered advisable, in certain cases, to limit the length of the voyage by emptying the balloon automatically.

The instrumental equipment of *ballons sondes* was first considered. M. Teisserenc de Bort presented a report on the determination of height by the barometer.

Drs. Assmann and Berson said that the usual methods gave considerable errors, and they recommended the calculation of the height by successive strata, applying a correction for the change of temperature of the lower stratum during the ascent. The Conference decided that—

> All nations should adopt the same formula of reduction, whatever method might be chosen ultimately.

M. Teisserenc de Bort analysed the errors of the aneroid with respect to the mercurial barometer, but in regard to the latter it was pointed out by Dr. Berson that the mercurial column only represents the atmospheric pressure at the moment when the balloon has no vertical velocity. It was resolved that—

> Simultaneous observations should be executed at the different stations, and that the instruments should be controlled by taking them in manned balloons. Besides this, the instruments ought to be interchanged among the different stations in as short a time as possible.

The determination of the temperature of the air in *ballons sondes* was introduced by a report of M. Teisserenc de Bort. Dr. Hergesell remarked that the temperature of the air varied so rapidly that it was necessary to apply a correction-formula which he had developed in the *Meteorologische Zeitschrift*, December 1897. M. Cailletet exhibited a thermometer of his invention, which had for its bulb a spiral silver tube soldered to a glass tube, both being filled with the liquid toluene. He stated that it acquired the surrounding temperature in fifteen seconds. M. Teisserenc de Bort exhibited a self-recording thermometer, having a thin blade of German silver fixed in a frame of Guillaume's invariable steel. This instrument takes the temperature of the air rapidly (9° F. in fifteen seconds), and it is not affected by shocks. The ventilation in a balloon is secured by a fan driven by a weight on a wire, which falls 5000 feet in an hour and a half. Drs. Hergesell and Assmann described their attempts to construct a sensitive metallic thermometer, which the latter thought might be ventilated by the agitation of the air through a jet of liquid carbonic acid, but M. Cailletet pointed out that at low temperatures the tension of carbonic acid is too slight to produce ventilation. Dr. Berson remarked that in his high ascent, the upper clouds, at an altitude of 24,000 to 29,000 feet, radiated upon the instruments in the same way as does the surface of the earth at a moderate height. As a result of the discussion it was resolved—

> (1) The rapidity of the thermometric variation is so great n *ballons sondes* that to record it thermometers must be employed which have much less thermal inertia than those hitherto employed, and (2) an efficient ventilation of the thermometers is indispensable.

The testing of thermometers at temperatures below those to which they would be exposed in *ballons sondes* was advised, and Dr. Erk described the apparatus of Dr. Linde, of Munich, for the production of a considerable quantity of liquid air. This means of refrigeration enables temperatures lower than 200° C. below zero to be obtained. The Conference recommended that—

> Before the ascensions of *ballons sondes* the instruments be verified by varying the temperature and pressure under conditions similar to those to which they would be subjected in the atmosphere.

The equipment of manned balloons was next considered. Some remarks of Dr. Berson on the difficulty of reading a mercurial barometer, owing to the continual oscillations of the mercury, led to the following resolution:

> During ascents, the mercurial barometer is the standard instrument for the comparison of aneroids, but for its observations to be trustworthy the acceleration must be zero; it is evident that this condition is fulfilled when the trajectory traced by the self-recording aneroid is horizontal.

In consequence of the statement that it was possible to verify the instruments by reproducing the curves traced by them, the Conference advised that—

> There should be reproduced in the laboratory, with the aid of pneumatic and refrigerating apparatus, similar curves to those traced by the barometer and thermometer during balloon ascents.

Furthur discussion followed as to the methods of obtaining the height of the balloon. M. Cailletet described his apparatus for automatically photographing together, from time to time, the ground vertically below the balloon and the face of an aneroid barometer. From a map the route of the balloon as well as its true altitude are determined; the pressure is deduced from the barometer, and thus the law connecting atmospheric pressure with altitude can be studied. Photographs have been taken from a balloon 7000 feet high, which was moving forty to sixty miles an hour. The accuracy of these measures was said to be within 1/250 of the height. It is proposed to photograph a mercurial barometer in the same way. The Conference recommended the use of M. Cailletet's apparatus for both manned balloons and *ballons sondes*. The determination of the height by observations at the ground was brought to the attention of the Conference, and especially the "dromograph," invented by MM. Hermite and Besançon, for automatically registering the azimuths and angular altitudes observed, and the heliometer used by Dr. Kremser, of Berlin, for measuring the apparent diameter of the balloon.

Dr. Erk called attention to the fact that in the case of a large difference of temperature between the wet and dry bulbs of the aspiration psychrometer, the wet bulb always had in its immediate neighbourhood a warmer body, which is the interior cylinder surrounding it. The resulting error may be avoided by covering the interior cylinder with muslin, so that the dry bulb is protected by a cylinder having a temperature, $t$, and the wet bulb by a cylinder having a temperature, $t'$. The Conference thought it necessary that—

> The instrumental equipment of manned balloons should be uniform, so far as possible. A recommendation has been made in regard to the barometers; concerning thermometers, the opinion is expressed that the aspiration psychrometer placed at the proper distance of at least 5 feet from the basket is the only instrument which should be employed in manned ascents. Simultaneous comparisons with the sling thermometer are recommended.

Drs. Berson and Hergesell urged the importance of simultaneous ascents in the different countries when a centre of barometric depression existed over the European Continent. From a purely meteorological point of view the manned ascents have an importance which the *ballons sondes* do not, because the temperature of these high regions can have no influence on the meteorological elements near the surface of the earth. M. de Fonvielle, however, insisted upon the interest of deducing experimentally, from thermometric measures at a very great elevation, the temperature of the supra-atmospheric medium.

He called attention to the possibility of choosing in this way between the kinetic theory of gases, which supposes a temperature of 273° C. below zero, and Fourier's theory which assumes that the temperature of space above the atmosphere is near that of the minima observed in the polar regions of the earth.

Future international balloon ascensions were next considered. It was deemed advisable that—

For each *ballon sonde* an instrument should be provided to serve as a basis of comparison with perfected instruments whose construction may change from one ascent to another on account of the improvements which may be attempted.

It was announced that in the next international ascent of *ballons sondes* Austria, Italy and Belgium would participate, besides the countries which had already co-operated. This ascent was appointed for the beginning of June with certain stations of the international system to be chosen as starting points. The balloons should be as nearly as possible like those approved by the Conference, and the directors of the various meteorological systems were requested to institute observations on the days of the ascents according to the principles fixed by the President of the Committee. It was recommended that—

For the simultaneous study of the lower air strata, the observations from high stations be used, and especially those from kites and kite balloons.

After a presentation of various methods for effecting the safe landing and the recovery of *ballons sondes*, resolutions looking to these ends were adopted. Balloons may be protected against explosion caused by atmospheric electricity by covering their interior surface with a solution of potassium chlorate, which renders the fabric a conductor. For the measurement of atmospheric electricity the methods of Le Cadet, Börnstein and André are recommended, especially the former.

Mr. Rotch read the report which he had been requested to prepare on the use of kites at Blue Hill Observatory, U.S.A., to obtain meteorological observations. He showed the advantages which kites possess over balloons up to heights exceeding 10,000 feet, whenever there is wind.

A letter from the Chief of the Weather Bureau explained the proposed use of kites to obtain data for a daily synoptic weather chart over the United States at the height of a mile or more. M. Teisserenc de Bort is equipping a kite station at Trappes, near Paris, after the model of Blue Hill, and General Rykatcheff stated that an anemograph of his invention was being raised with Hargrave kites at St. Petersburg. The Conference recommended the use of the kite in meteorology, and expressed the wish that all central observatories should make such observations, which are of prime importance for meteorology. On account of the favourable position of Mounts Cimone and Etna it is desirable that at the observatories on these mountains kites should be used in connection with the international balloon ascensions. The Conference expressed the desire that the chief observatories should be provided with the kite balloon of von Parseval and von Siegsfeld (see description hereafter) in order that there may be a certain number of permanent aerial stations, and following the idea of M. Tacchini it is hoped that kite balloons will be used in Italy on Mounts Viso and Etna, and also at the Military Park at Rome.

The following new members of the Committee were elected: M. Teisserenc de Bort and Prince Roland Bonaparte, of Paris, Prof. Hildebrandsson, of Upsala, Prof. Pernter and Lieut. Hinterstoisser, of Vienna, Captain Moedebeck, of Strassburg, and Lieut. von Siegsfeld, of Berlin. The next meeting was appointed for 1900, at Paris, during the Universal Exposition.

The Committee had the opportunity of witnessing two trials of the captive kite balloon, invented by Lieuts. von Parseval and von Siegsfeld, and constructed by Riedinger, of Augsburg, at a cost of 1000 dols., for Prof. Hergesell and Captain Moedebeck. Although this form of balloon is used in the German army for reconnoitring, it was now employed for the first time to lift self-recording meteorological instruments. The cylindrical balloon is so attached to the cable that its upper end inclines towards the wind, which thus raises instead of depressing it, as in the case of captive spherical balloons. The wind enters an auxiliary envelope at the lower extremity and maintains the cylindrical form, notwithstanding any loss of gas. This wind bag also serves as a rudder, while lateral wings prevent rotation about the longer axis. The Strassburg balloon has a diameter of 14·7 feet, a length of 55·7 feet, and a volume of 7770 cubic feet. The gas bag is varnished linen, and was filled with a mixture of hydrogen and coal gas. The weight of the balloon complete is 230 pounds, and the steel cable holding it weighs 2 pounds per 100 feet. The azimuth, altitude, and traction of the cable are recorded by a dynamometer invented by Riedinger. The meteorological instruments are contained in a basket (with open ends, through which the wind blows, but covered elsewhere with nickeled paper as a protection against insolation), suspended some 40 feet below the balloon. The self-recording instruments were a barometer and thermometer of Richard and a Robinson anemometer recording electrically. Although the kind of gas employed was hardly sufficient to lift the unnecessarily heavy basket and its contents, weighing 80 pounds, yet the trials made in rainy and windy weather were fairly successful, and a height of about 1000 feet was reached. Without instruments the balloon had remained for several days above the city, and had withstood a gale.

The Committee also saw a hastily organised ascent of the *ballon sonde*, "Langenburg," which is a silk balloon of about 14,000 cubic feet capacity. When filled with coal gas it had an initial ascensional force of about 440 pounds in excess of its own weight and that of the instruments, contained in a cylindrical basket, which was open at top and bottom for ventilation, and was also covered with nickeled paper. They comprised a barometer and thermometer of Richard, and the metallic thermometer of Teisserenc de Bort, which all recorded on smoked paper. Owing to the premature launch of the balloon the ballast was left behind, and the escape of gas, owing to the too rapid ascent, prevented a great height from being reached. The balloon rose at about 6 p.m. with a velocity of nearly 23 feet per second, and disappeared in the strato-cumulus clouds in five minutes. It attained an altitude exceeding 6 miles, and fell about 60 miles south-east of Strassburg, where it was found the next day. Unfortunately the shock caused by the breaking loose of the balloon stopped the clocks of the thermographs and prevented records of temperature from being obtained.

An official account of this Conference will be published in the French and German languages, together with the special reports prepared by the experts.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

AMONG the measures which received the Royal consent on Friday was the London University Commission Bill.

MR. A. J. HERBERTSON, Lecturer on Geography in the Heriot-Watt College, Edinburgh, has taken the degree of Ph.D., *multa cum laude*, in the University of Freiburg, Baden, in the special subject of geography. The subject of his thesis was the mean monthly rainfall of the globe, illustrated by twelve original maps.

THE resident professorship of Physics and Mechanics in the Royal Agricultural College, Cirencester, has been filled up by the election of Mr. John Alexander Johnston. At Edinburgh Mr. Johnston was first medallist in advanced honours class of mathematics, and first medallist in advanced honours class of physics, and in 1894 he graduated M.A. with first class honours in mathematics and physical science, and afterwards obtained the Drummond scholarship for proficiency in physical science, as well as other open honours. At Pembroke College, Cambridge, he was awarded both minor and foundation scholarships, and graduated fourteenth wrangler in the mathematical tripos.

A SPECIAL and valuable feature of the Museum of the Peabody Institute at Salem, Mass., is referred to by Mr. W. E. Hoyle in the course of a description of museums in the United States and Canada, contained in the report of the Manchester Museum, Owens College (1897–8). Mr. Hoyle mentions that at close intervals throughout the entire collection special coloured labels are displayed, calling attention, by title and shelf number, to books in the public library referring to the immediate group, so that a student or pupil from the public schools need only transcribe on a bit of paper a set of numbers and present it at the delivery window of the public library to be provided at once with the books on the special subject desired.

THE following list of candidates successful in this year's competition for the Whitworth Scholarships and Exhibitions, has been issued by the Department of Science and Art:—Scholarships of 125*l.* a year, tenable for three years—Charles E. Goodyear, Devonport; John H. Grindley, Oldham; Harry E. Wimperis, Bath; George Service, Cambuslang. Exhibitions of 50*l.* a year, tenable for one year—William V. Shearer, Glasgow; William Alexander, Glasgow; Albert Hall, London; Aidan N. Henderson, Edinburgh; Alec W. Quennell, London; Victor G. Alexander, Portsmouth; George S. Taylor, Devonport; Joel J. Lee, Portsmouth; George Donington, Lincoln; John E. Jagger, Manchester; George A. Inglis, Glasgow; Leslie H. Hounsfield, London; William M. Selvey, Devonport; Ernest A. Forward, London; James J. Mills, Plumstead; Robert M. Neilson, Glasgow; William A. Barnes, Horwich (Lancs.); Francis P. Johns, Torpoint; Herbert H. Johnson, Liverpool; William T. Williams, London; Frederick Charlesworth, Crewe; William A. Craven, Birkenhead; George A. Barber, Manchester; Hugh M. Macmillan, Govan; James C. Macfarlane, Cathcart; George G. Sumner, Manchester; Charles L. Vaughan, Plumstead; William E. M. Curnock, Liverpool; Francis D. Moulang, Inchicore (Dublin); John Webster, Gateshead.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Society**, June 9.—"On the Position of Helium, Argon, and Krypton in the Scheme of Elements." By Sir William Crookes, F.R.S.

It has been found difficult to give the elements argon and helium (and I think the same difficulty will exist in respect to the gas krypton) their proper place in the scheme of arrangement of the elements which we owe to the ingenuity and scientific acumen of Newlands, Mendeléef and others. Some years ago, carrying a little further Prof. Emerson Reynolds's idea of representing the scheme of elements by a zigzag line, I thought of projecting a scheme in three dimensional space, and exhibited at one of the meetings of the Chemical Society[1] a model illustrating my views. Since that time, I have rearranged the positions then assigned to some of the less known elements in accordance with later atomic weight determinations, and thereby made the curve more symmetrical.

Many of the elemental facts can be well explained by supposing the space projection of the scheme of elements to be a spiral. This curve is, however, inadmissible, inasmuch as the curve has to pass through a point neutral as to electricity and chemical energy twice in each cycle. We must therefore adopt some other figure. A figure-of-eight will foreshorten into a zigzag as well as a spiral, and it fulfils every condition of the problem. Such a figure will result from three very simple simultaneous motions. First, an oscillation to and fro (suppose east and west); secondly, an oscillation at right angles to the former (suppose north and south); and thirdly, a motion at right angles to these two (suppose downwards), which, in its simplest form, would be with unvarying velocity.

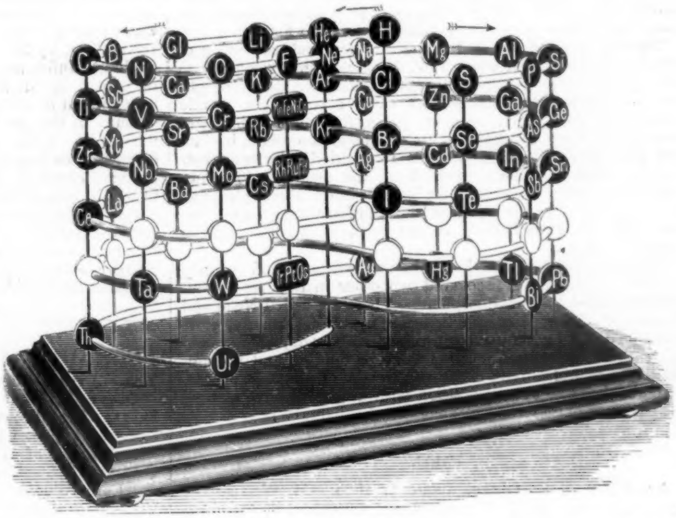
I take any arbitrary and convenient figure-of-eight, without reference to its exact nature; I divide each of the loops into eight equal parts, and then drop from these points ordinates corresponding to the atomic weights of the first cycle of elements. I have here a model representing this figure projected in space; in it the elements are supposed to follow one another at equal distances along the figure-of-eight spiral, a gap of one division being left at the point of crossing. The vertical height is divided into 240 equal parts on which the atomic weights are plotted, from H = 1 to Ur = 239·59. Each black disc represents an element, and is accurately on a level with its atomic weight on the vertical scale.

The accompanying figure, photographed from the solid model, illustrates the proposed arrangement. The elements falling one under the other along each of the vertical ordinates, are

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | He | Li | Gl | B | C | N | O | F | Na | Mg | Al | Si | P | S |
| Cl | Ar | K | Ca | Sc | Ti | V | Cr | Mn·Fe·Ni·Co | Cu | Zn | Ga | Ge | As | Se |
| Br | Kr | Rb | Sr | Yt | Zr | Nb | Mo | Rh·Ru·Pd | Ag | Cd | In | Sn | Sb | Te |
| I | — | Cs | Ba | La | Ce | ( ) | ( ) | ( ) | ( ) | ( ) | ( ) | ( ) | ( ) | ( ) |
| ( ) | — | ( ) | ( ) | ( ) | ( ) | Ta | W | Ir·Pt·Os | Au | Hg | Tl | Pb | Bi | — |
| — | — | — | — | — | Th | — | Ur | — | — | — | — | — | — | — |

The bracketed spaces between cerium and tantalum are probably occupied by elements of the didymium and erbium groups. Their chemical properties are not known with sufficient accuracy to enable their positions to be well defined. They all give coloured absorption spectra, and have atomic weights between these limits. Positions marked by a dash (—) are waiting for future discoverers to fill up.

Let me suppose that at the birth of the elements, as we now know them, the action of the *vis generatrix* might be diagrammatically represented by a journey to and fro in cycles along a figure-of-eight path, while, simultaneously, time is flying on, and some circumstance by which the element-forming cause is conditioned (*e.g.* temperature) is declining; (variations which I have endeavoured to represent by the downward slope). The result of the first cycle may be represented in the diagram by supposing that the unknown formative cause has scattered along its journey the groupings now called hydrogen, lithium, glucinum, boron, carbon, nitrogen, oxygen, fluorine, sodium, magnesium, aluminium, silicon, phosphorus, sulphur, and chlorine. But the swing of the pendulum is not arrested at the end of the first round. It still proceeds on its journey, and had the conditions remained constant, the next elementary grouping generated would again be lithium, and the original cycle would eternally reappear, producing again and again the same fourteen elements. But the conditions are not quite the same. Those represented by the two mutually rectangular horizontal components of the motion (say chemical and electrical energy) are not materially modified; that to which the vertical component corresponds has lessened, and so, instead of lithium being repeated by lithium, the grouping which forms the commencement of the second cycle is not lithium, but its lineal descendant, potassium.




It is seen that each coil of the lemniscate track crosses the neutral line at lower and lower points. This line is neutral as to electricity, and neutral as to chemical action. Electro-positive elements are generated on the northerly or retreating half of the swing, and electro-negative elements on the southerly or approaching half. Chemical atomicity is governed by distance from the central point of neutrality; monatomic elements being one remove from it, diatomic elements two removes, and so on. Paramagnetic elements congregate to the left of the neutral line, and diamagnetic elements to the right. With few exceptions, all the most metallic elements lie on the north.

Till recently chemists knew no element which had not more or less marked chemical properties, but now by the researches of Lord Rayleigh and Prof. Ramsay, we are brought face to face with a group of bodies with apparently no chemical properties

[1] Presidential address to the Chemical Society, March 28, 1888.

forming an exception to the other chemical elements. I venture to suggest that these elements, helium, argon, and krypton in this scheme naturally fall into their places as they stand on the neutral line. Helium, with an atomic weight of 4, fits into the neutral position between hydrogen and lithium. Argon, with an atomic weight of about 40, as naturally falls into the neutral position between chlorine and potassium. While krypton, with an atomic weight of about 80, will find a place between bromine and rubidium.

See how well the analogous elements follow one another in order: C, Ti, and Zr; N and V; Gl, Ca, Sr, and Ba; Li, K, Rb, and Cs; Cl, Br, and I; S, Se, and Te; Mg, Zn, Cd, and Hg; P, As, Sb, and Bi; Al, Ga, In, and Tl. The symmetry of these series shows that we are on the right track. It also shows how many missing elements are waiting for discovery, and it would not now be impossible to emulate the brilliant feat of Mendeléef in the celebrated cases of Eka-silicon and Eka-aluminium. Along the neutral line alone are places for many more bodies, which will probably increase in density and atomic weight until we come to inert bodies in the solid form.

Three groups are seen under one another, each consisting of closely allied elements which Prof. Mendeléef has relegated to his eighth family. They congregate round the atomic weight 57, manganese, iron, nickel and cobalt; round the atomic weight 103, ruthenium, rhodium and palladium; while lower down round atomic weight 195 are congregated osmium, iridium and platinum. These groups are interperiodic because their atomic weights exclude them from the small periods into which the other elements fall; and because their chemical relations with some members of the neighbouring groups show that they are interperiodic in the sense of being formed in transition stages.

[*Note, June* 22.—Since the above was written, Prof. Ramsay and Mr. Travers have discovered two other inert gases accompanying argon in the atmosphere. These are called Neon and Metargon. From data supplied me by Prof. Ramsay, it is probable that neon has an atomic weight of about 22, which would bring it into the neutral position between fluorine and sodium. Metargon is said to have an atomic weight of about 40; if so, it shares the third neutral position with argon. I have marked the positions of these new elements on the diagram.]

PARIS.

**Academy of Sciences,** August 8, 1898.—M. Wolf in the chair.—On the theory of the zenithal telescope, by M. Hatt. An exposition in reply to some objections raised by M. Verschaffel.—Some points in the normal and pathological physiology of the heart, revealed by radioscopic examination, by M. Ch. Bouchard. This paper treats of the movements of the heart during respiration, both in the normal state and in the presence of diseases of the respiratory organs.—The double embryo of *Diplosomides* and tachygenesis, by MM. Edmond Perrier and Antoine Pizon.—The number and symmetry of the libero-ligneous bundles of the petiole as a measure of the gradation of vegetable species, by M. Ad. Chatin. The monocotyledons are dealt with in this article.—Experiments on the production of Alpine characters in plants by the alternation of extreme temperatures, by M. Gaston Bonnier. Comparative experiments were made with a number of plants cultivated under three different sets of conditions, the first being maintained at a constant low temperature (4° to 9° C.), the second subjected to the normal variations in temperature in the neighbourhood of Paris, and the third maintained at a very low temperature during the night and exposed to the sun in the day. Under the last-named conditions the plants exhibited the stunted growth, the short internodes, the small thick leaves, and the speedy efflorescence characteristic of Alpine species.—On the preparation of cultures of Koch's bacillus, most favourable for the study of the phenomena of agglutination in the blood-serum of tuberculous subjects, by MM. S. Arloing and Paul Courmont.—On the infinitely small deformation of an elastic ellipsoid, by MM. E. and F. Cosserat.—On simple kathode rays, by M. E. Goldstein.—On the superposition of two stereoscopic couples, by MM. T. Marie and H. Ribaut.—On monopyrocatechin glyoxal, by M. Ch. Moureu. The compound of the formula $C_8H_8O_4$, recently described by M. Julius Hesse, and obtained by him from a derivative of monopyrocatechin glyoxal, is shown to be identical with the orthohydroxyphenoxy-acetic acid produced by hydrolysis of ethane-dipyrocatechin (dipyrocatechin glyoxal). This result confirms the author in his supposition that monopyrocatechin glyoxal is an intermediate product in the hydrolysis of dipyrocatechin glyoxal.—Action of oxygen upon yeast, by M. Jean Effront. On exposure of yeast to air, absorption of oxygen takes place, accompanied by a considerable rise of temperature. This is due to the presence of an oxidising enzyme which will be subsequently described.—Study of the phosphoric acid dissolved by the water of the soil, by M. Th. Schlœsing fils. As has been already pointed out, the percentage of phosphoric acid held in solution by the water of the soil depends only on the nature of the latter, and is independent of the absolute amount of water present. On this fact is based a simple and expeditious method of determining the dissolved phosphoric acid in soils. The sample is agitated for ten hours with a large volume of water and the phosphoric acid estimated in an aliquot part of the clarified liquid. The result thus obtained, combined with a determination of the moisture in the soil, gives the information required.—On the mechanism of immunisation against the globulicidal action of snake serum, by MM. L. Camus and E. Gley.—Transmission of toxines from the fœtus to the mother, by M. A. Charrin. Experiments were made upon rabbits.—Influence of carbonic acid on the form and structure of plants, by M. Em. C. Téodoresco. Plants were grown in air deprived of carbonic acid, and in air to which a definite amount of the gas had been added. Certain morphological differences were observed.—"Jaundice," a bacteriological disease of the beetroot, by MM. Prillieux and Delacroix. The bacterial nature of the disease has been demonstrated, and confirmed by inoculation experiments.—Apparatus for taking radiographs of the thoracic cage during inspiration and expiration: results obtained, by M. Guilleminot. The construction of the apparatus was suggested by the experiments of M. Bouchard, whose observations are confirmed.—A luminous meteor, observed at Bourg-d'Ault (Somme), by M. C. Rozé.

## CONTENTS.

# MACMILLAN & CO.'S BOOKS
FOR
# STUDENTS OF ZOOLOGY.

**A TEXT-BOOK OF ZOOLOGY.** By T. JEFFERY PARKER, D.Sc., F.R.S., Professor of Biology in the University of Otago, Dunedin, N.Z., and WILLIAM A. HASWELL, M.A., D.Sc., F.R.S., Professor of Biology in the University of Sydney, N.S.W. In Two Vols. With Illustrations. Medium 8vo, 36*s.* net.

*LITERATURE.*—"The scheme of classification is on the whole so good that even those who find fault with matters of detail will admit its general excellence. The sections on Distribution—geographical, bathymetrical, and geological—and on The Philosophy of Zoology have been written with extreme care, the latter especially being full of pregnant remarks and suggestions. A useful chapter on the History of Zoology is appended, from which a true idea of the perspective of things can be gathered. Both volumes are copiously indexed, and reference to any heading is thus made easy."

**A TEXT-BOOK OF ENTOMOLOGY, including the Anatomy, Physiology,** Embryology and Metamorphoses of Insects, for use in Agricultural and Technical Schools and Colleges, as well as by the working Entomologist. By ALPHEUS S. PACKARD, M.D., Ph.D., Professor of Zoology and Geology, Brown University. Medium 8vo, 18*s.* net.

*LITERATURE.*—"Dr. A. S. Packard has attempted no easy task, but his thirty years' study oι the huge class of insects qualifies him to accomplish it, and he is to be congratulated on his work."

**ESSAYS ON MUSEUMS AND OTHER SUBJECTS CONNECTED WITH** NATURAL HISTORY. By Sir WILLIAM HENRY FLOWER, K.C.B., D.C.L., D.Sc., LL.D., Ph.D., F.R.S., F.R.C.S., P.Z.S., Correspondent of the Institute of France, &c. Demy 8vo, 12*s.* net.

*ATHENÆUM.*—"Many of the essays possess permanent value, and all were well worthy of being printed afresh."

A TEXT-BOOK of COMPARATIVE ANATOMY. By Dr. ARNOLD LANG, Professor of Zoology in the University of Zürich. With Preface to the English Translation by Dr. ERNST HAECKEL. Translated by HENRY M. BERNARD, M.A. Cantab., and MATILDA BERNARD. Vols. I. and II. (completing the Invertebrates). 8vo. 17*s.* net each.

LESSONS in ELEMENTARY ANATOMY. By ST. GEORGE MIVART, F.R.S., Author of "The Genesis of Species." Fcap. 8vo. 6*s.* 6*d.*

ELEMENTS of the COMPARATIVE ANATOMY OF VERTEBRATES. Adapted from the German of ROBERT WIEDERSHEIM, Professor of Anatomy, and Director of the Institute of Human and Comparative Anatomy in the University of Freiburg, in Baden. By W. NEWTON PARKER, Professor of Biology in the University College of South Wales and Monmouthshire. With additions by the Author and Translator. 270 Woodcuts. Medium 8vo. Second Edition. 12*s.* 6*d.* net.

The STRUCTURE of MAN: An INDEX to his PAST HISTORY. By ROBERT WIEDERSHEIM. Translated by H. and M. BERNARD. The Translation, Edited and Annotated, and a Preface written by G. B. HOWES, F.R.S., Professor of Zoology, Royal College of Science, London. With 105 Figures in the Text. 8vo. 8*s.* net.

A COURSE of INSTRUCTION in ZOOTOMY. Vertebrata. By T. JEFFERY PARKER, F.R.S., Professor of Biology in the University of Otago, New Zealand. With Illustrations. Crown 8vo. 8*s.* 6*d.*

An INTRODUCTION to the OSTEOLOGY OF THE MAMMALIA. By Sir WILLIAM HENRY FLOWER, F.R.S., F.R.C.S., Director of the Natural History Department of the British Museum. Illustrated. Third Edition. Revised with the assistance of HANS GADOW, Ph.D., Lecturer on the Advanced Morphology of Vertebrates in the University of Cambridge. Crown 8vo. 10*s.* 6*d.*

A TREATISE on COMPARATIVE EMBRYOLOGY. By the late Prof. F. M. BALFOUR, M.A., F.R.S. In two Vols. Second Edition. Medium 8vo. Vol. I. 18*s.* Vol. II. 21*s.*

The ELEMENTS of EMBRYOLOGY. By Prof. MICHAEL FOSTER, M.D., F.R.S., and the late Prof. F. M. BALFOUR, F.R.S. Second Edition, revised. Edited by A. SEDGWICK, M.A., and W. HEAPE, M.A. Illustrated. Crown 8vo. 10*s.* 6*d.*

STRUCTURE AND LIFE of BIRDS. By F. W. HEADLEY, Assistant Master at Haileybury College. Illustrated. Crown 8vo. 7*s.* 6*d.*

The NATURAL HISTORY of the MARKETABLE MARINE FISHES of the BRITISH ISLANDS. By J. T. CUNNINGHAM, M.A. With Preface by E. RAY LANKESTER, F.R.S. Illustrated. Medium 8vo. 7*s.* 6*d.* net.

NATURAL HISTORY of AQUATIC INSECTS. By L. C. MIALL, F.R.S., Professor of Biology in the Yorkshire College, Leeds. Illustrated. Crown 8vo. 6*s.*

THE ORIGIN AND METAMORPHOSES of INSECTS. By Sir JOHN LUBBOCK, F.R.S. With Illustrations. 3*s.* 6*d.* [*Nature Series.*

MONOGRAPH of the BRITISH CICADÆ or TETTIGIIDE (Froghoppers and Grass-flies). By GEORGE BOWDLER BUCKTON, F.R.S., Illustrated by more than 400 Coloured Drawings. Two Vols. Demy 8vo. 33*s.* 6*d.* each, net. Also in Eight Parts. 8*s.* each, net.

A HANDBOOK OF BRITISH LEPIDOPTERA. By EDWARD MEYRICK, B.A., F.Z.S., F.E.S., Assistant Master at Marlborough College. Extra Crown 8vo. 10*s.* 6*d.* net.

MACMILLAN AND CO., LIMITED, LONDON.